TRAFFIC ENGINEERING & CONTROL

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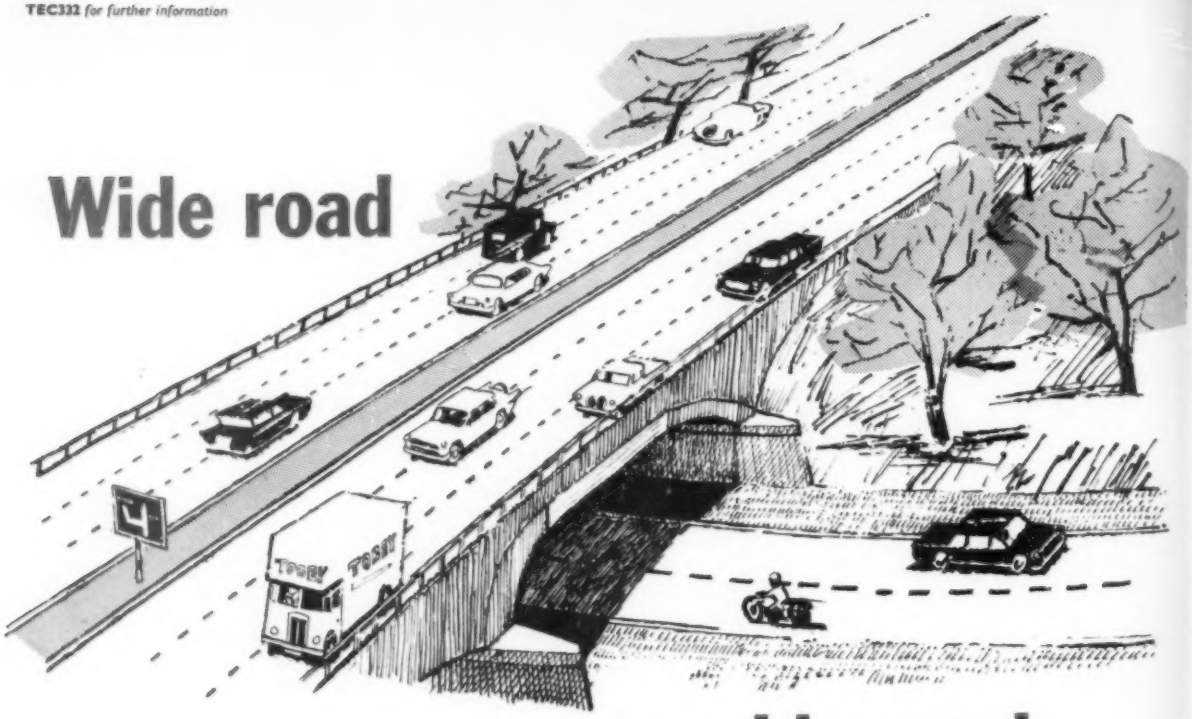

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TRAFFIC ENGINEERING & CONTROL

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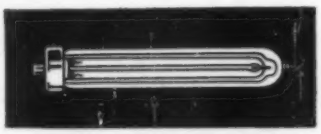

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Traffic Engineering in 1960

DURING the past year there has been evidence of a growing recognition of the contribution that the application of traffic engineering techniques can make towards the resolving of the country's road and traffic problems, and there is every indication of its increasing use in the present year. A growing number of Highway and Traffic Authorities provide evidence in practical form of the appreciation of the need for scientific assessment of needs before proceeding with plans by undertaking traffic surveys before finalizing them. It is equally gratifying that the Ministry of Transport, on occasion, is encouraging, to a greater extent than formerly, local authorities to embark upon such studies before authorizing new road construction or major improvements.

Other indications given during the year of the increasing importance of those concerned with roads and traffic having a greater understanding of traffic engineering include the holding of the first examination for the Diploma in Traffic Engineering by the Institution of Highway Engineers, the inclusion of traffic engineering in the curriculum for the examination of the Institution of Civil Engineers (the Scottish Branch of which has followed the parent body's example and set up a Traffic Engineering Study Group), and the starting of courses in the subject by a number of technical colleges. Most important in the extension of technical education in this field, however, is the recent establishment of a new Readership in Highway and Traffic Engineering at the University of Durham, whose Professor in Civil Engineering, Dr. W. Fisher Cassie, with enterprise and foresight, and with assistance from the Rees Jeffreys Road Fund, has pioneered traffic engineering among the universities of this country since 1952. It is in recognition of the work of Dr. T. E. H. Williams, who heads the Highway and Traffic Engineering Section at the University of Durham, that led the University to award him a personal readership to be known as the Rees Jeffreys Readership in Highway and Traffic Engineering. This follows less than two years after the establishment of a Chair in the same subject at the University of Birmingham, and it is significant that in both cases traffic engineering as such is included in the title. This is as it should be, because the subject needs to be recognized in its own right and not merely as an adjunct of civil engineering. In fact, the time may be approaching when traffic engineering will figure more prominently in the examinations for some engineering degrees and traffic engineers will not be required to qualify in all those aspects of, for instance, constructional engineering, as they now do.

Meanwhile, it is desirable that those post-graduate courses in traffic engineering which are available be made more accessible to those already qualified in the engineering field. One difficulty is that those wishing to extend their knowledge by availing themselves of them are already in employment and find it difficult to get the necessary leave of absence, particularly if they are employed by local authorities, even if they are willing or able to finance themselves, which is far from always the case. Scholarships are few and need to be increased and local authorities should be enabled to make it easier for those of their officers, who it is desirable should become qualified in this field, to take these courses. One consequence of these difficulties is that a large number of places are filled by students from overseas, and gratifying and valuable as this is in many ways, as long as there is a shortage of fully qualified traffic engineers in this country, and the need is great and increasing, the larger number from this country who can take the courses, the better. The Road Research Laboratory courses, described in later pages, cannot meet this difficulty because although they are of great value in teaching modern developments in the field of traffic and safety they are so limited in time, and consequently in scope, that they are not comparable with a full university course. A certain way of increasing the intake at the universities and technical colleges, and thereby meeting the need for more traffic engineers, would be to raise their status and, in this connection, Mr. Ogden's views, published in this month's issue, are of interest even if they will not be shared by all. As long as the traffic engineer is not recognized as a sufficiently qualified specialist to rank equally with other engineers, civil, highway or electrical, for instance, there is likely to be some reluctance to seek specialization in the subject.

While, therefore, 1960 saw some progress towards wider use of traffic engineering methods and techniques, and a greater appreciation of the contribution it can make to the solution of roads and traffic problems, and while there was a welcome advance in the provision of better opportunities for obtaining specialized training in the subject, it is to be hoped that during 1961 not only will traffic engineering be accepted as necessary to their roads and traffic planning by a greater number of authorities but also that more will follow in their appropriate form, the example of Lancashire in establishing a traffic engineering section, as described in later pages, and finally, that greater consideration will be given to the place that the traffic engineer should occupy not only in his employment but in regard to the requisite qualification for engineering degrees and membership of the professional institutions.

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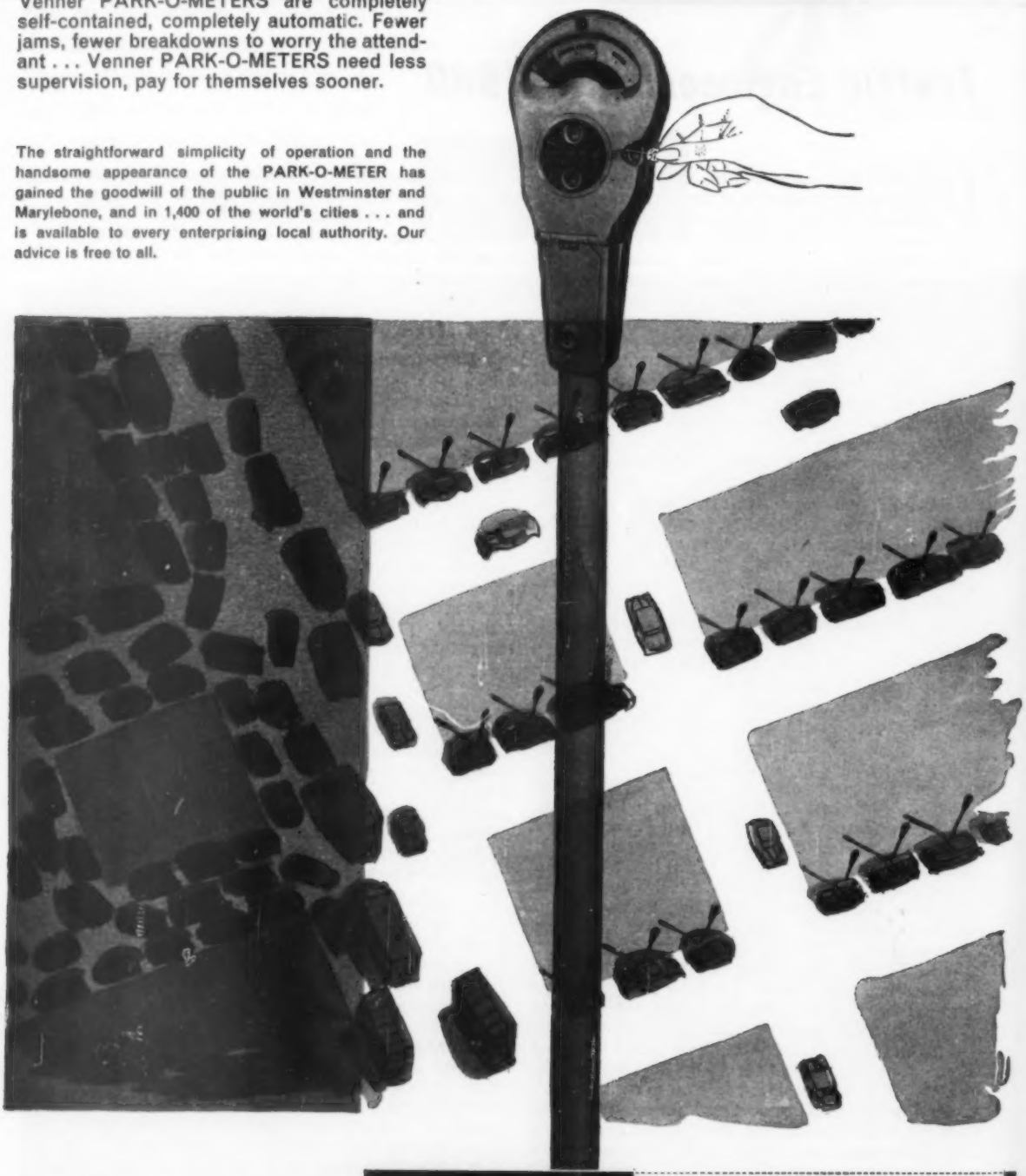

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Topics of the Month...

THE London County Council announced last month that the large-scale traffic survey for the County of London is to be planned by the London consulting engineers, Freeman Fox and Partners, who will work in association with an American firm of traffic engineering consultants, Engineering Service Corporation of Los Angeles, which incorporates Wilbur Smith and Associates. When it was proposed in the September issue of this Journal that it might be desirable for outside consultants to be called in for this survey, there was some criticism that this was not only unnecessary but that if foreign consultants were employed British firms would lack the opportunity of learning traffic engineering know-how. The present arrangement for London follows the pattern suggested here, and fully meets such criticism, since it makes the best possible provision for American experience to be at the disposal of British consultants. A growing number of civil engineering firms are establishing traffic engineering sections on the basis of British American association and this should further encourage this development and assist them in their work overseas, where traffic engineering is often practised more than here, notably in the older Commonwealth countries.

The London survey will be by far the largest traffic study yet undertaken in this country and will cover public as well as private transport. Since it is desirable that it be conducted as speedily as is consistent with thoroughness, it is doubtful whether for so great an area a comprehensive origin-destination survey and its analysis could be conducted in reasonable time. Consequently, a limited home interview survey with an O-D survey conducted on the basis of random sampling will probably be undertaken and should provide the necessary information. To date, London has had no long-term roads programme based on traffic and travel data and this gap will now be filled, and it is to be hoped that it will lead to one now being drawn to known needs and not merely patterned to the limited and inadequate funds so far made available.

Case for Urban Motorways

TWO strong cases for urban motorways were made last month: by the British Road Federation in its evidence in objection to the County of London Revised Development Plan, and by Prof. W. Fisher Cassie speaking to the House of Commons Roads Study Group. Counsel for the BRF drew attention to the omission of any reference to urban motorways in the Revised Plan although they had been referred to as being taken into consideration in the 1951 Plan, which was based on an increase of only 50 per cent in traffic, half of which had already been realized. He drew attention to the BRF plan for a ring road with radials following, in the main, railway tracks. Prof. Cassie argued, on the other hand, that such schemes would not solve the problem of congestion because a very high proportion of traffic on city streets was self-generated and little could be diverted by ring roads. Since unless vehicles were allowed to enter the central business district of the city it begins to decay and decentralization of retail business and commerce takes place, urban motorways leading right into the central areas were essential. They would have to be close to the points of highest congestion so that they attracted vehicles even for their short journeys and would have to pass close to and through the business districts. As an alternative to the ring roads and radials Prof. Cassie proposed distributive loops of motorways crossing each other at a few important intersections and with slip roads to enable short journeys to be made to the vehicle's destination. Because of its importance it is proposed to publish Prof. Cassie's paper in next month's issue of this Journal.

Alcohol and the Road User

THE provisional figures of road casualties over the Christmas holiday, while showing an encouraging reduction over the year before, still show a considerable rise above normal. It is too early to conclude as to the extent to which the intense propaganda was effective but it appears to have had some result. Until a detailed analysis of the accidents has been made, with such factors as traffic density, road conditions and weather taken into account, no final conclusion can be drawn as to the reason for the reduction nor, for that matter, for the increase at this time of year, although there is much circumstantial evidence that the consumption of alcohol plays its part. Last year's analysis by the Road Research Laboratory indicated this possibility inasmuch as a high proportion of those concerned in accidents had previously taken alcohol. Projected road safety legislation is likely to include some strengthening of the law in regard to driving after drinking but the determination of any fair test is difficult.

The Wine Trade Defence Committee, with the assistance of a medical doctor, have set out to show that alcohol as a cause of accidents may be considerably exaggerated. Reason for their action is their fear that the proposed road safety legislation will impose unfair tests as to alcoholic content. They accept that it is deplorable that anyone should drive when so seriously affected by alcohol as to be unfit to do so, but oppose any test of alcohol in the system because of the impossibility of instituting a test of alcoholic content which would take into account the differing effects of alcohol on different individuals and at different times on the same individual. To impose any test with the permissive level of alcohol arbitrarily determined, as it would have to be, in their opinion, would result inevitably in injustice to some. The case against such tests is strong but the fact remains that the present law, despite the severe penalties, including disqualification, that it provides, fails to act as an effective deterrent and consequently a number of accidents occur which might otherwise be avoided.

BEFORE and after STUDY

Traffic Conditions and Driver Behaviour at a Signed Roundabout

by J. A. Reid, *Road Research Laboratory*

Fig. 1. Traffic roundabout, Tees (Newport), Middlesbrough, the subject of this study.

SIGNS asking drivers to give way to traffic coming from their right were installed at a traffic roundabout at Tees (Newport), Middlesbrough. This small roundabout at times becomes severely congested and it was thought that the signs might help to relieve congestion by promoting a freer flow of vehicles. In order to determine the effect of the signs, studies of driver behaviour, traffic flow and journey times were made at various times during the day, both before and after the signs were installed. The experiment was carried out by the Road Research Laboratory at the suggestion of the Middlesbrough Borough Engineer and Surveyor, and with his active co-operation.

According to the 'right-hand' priority rule of behaviour at roundabouts, if a driver approaching a roundabout sees that his vehicle will be impeded by one already on the roundabout and approaching him from the right, he should slow down and give way. Supporters of the rule claim that, in addition to the advantages arising from drivers knowing what to expect from one another, it provides a better chance of avoiding 'locking' of the roundabout during periods of high traffic flow, since there will be less likelihood of vehicles on the roundabout being forced to come to a standstill.

Site of Experiment

The Tees (Newport) Bridge roundabout, Middlesbrough, is situated at the junction of A176 and A1130,

where the main Middlesbrough-Stockton road is met by the main cross-river road from Billingham and West Hartlepool. The roundabout with its approaches is shown in Fig. 2 with the locations of the observation points indicated. Photographs of the site are reproduced in Figs. 1 and 3. Space is restricted at the site and the roundabout is necessarily a small one, the central island being only about 75 ft. in diameter, with the result that the weaving area is very restricted. There is a one way system to the south of the roundabout, where vehicles leave by Heywood Street and approach by Ayresome Grange Road.

To the north is Tees (Newport) Bridge, a lift bridge that is very occasionally raised; when it is raised the flow of traffic to and from the north is cut for periods of about five minutes. Since the bridge was only raised on one occasion during the five days when observations were being made, and since this took place during a relatively quiet period, it was not possible to make a study of its effect on traffic congestion. Also north of the roundabout, and parallel with the Bridge Approach, are two small streets, Calvert Street and Samuelson Street, which are mainly used for parking purposes, and since vehicles enter and leave them relatively infrequently they have been disregarded.

Design of Experiment

To determine the effect of the signs, it was decided to carry out a 'before and after' experiment in which the following studies would be made:

(*a*) Observation of the behaviour of a random sample of drivers entering the roundabout at each approach.
(*b*) Measurement of the time taken by these drivers to pass through the roundabout.
(*c*) A count of all vehicles entering the roundabout by each approach, to take place simultaneously with (*a*) and (*b*).
(*d*) Observation of the exits taken by the drivers in the random sample.

The observations were carried out by a team of eight observers, four of whom were engaged in the vehicle count while the other four made the remaining observations.

The 'before' observations were made on Tuesday and Wednesday, September 23 and 24, 1958, and the 'after' observations on Tuesday 21, and Wednesday 22, and April 23, 1959. Seven members of the Borough Surveyor's staff and one member of the Road Research Laboratory made the 'before' observations, while the 'after' observations were made by four of the Borough Surveyor's staff and four Road Research Laboratory staff. The weather was fine throughout the five observation days except for the latter half of the afternoon of September 23 when there was heavy rain.

The signs were installed on October 1958 and one of them is shown in Fig. 3. They are about 4 ft. x 3 ft. in size and the legend GIVE WAY TO TRAFFIC FROM YOUR RIGHT is in white letters about 7 in. high, on a red background.

For several reasons, it was decided to make observations during periods when the traffic flow was comparatively light as well as during peak periods:

(1) To obtain information regarding the extent of the increase in traffic flow at peak periods,
(2) To find out to what extent driver behaviour changed when conditions became busy.
(3) To find out what difference in journey times was involved.

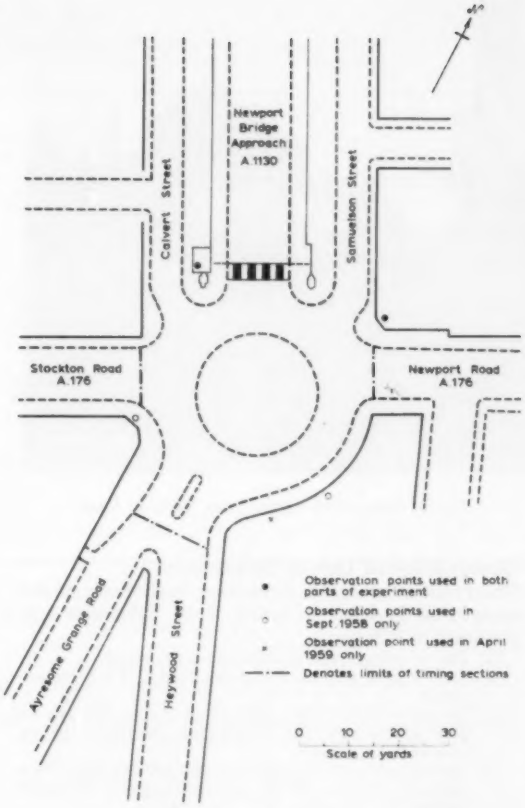
Newport Bridge Approach A.1130
Calvert Street
Samuelson Street
Stockton Road A.176
Newport Road A.176
Ayresome Grange Road
Heywood Street
Observation points used in both parts of experiment
Observation points used in Sept. 1958 only
Observation point used in April 1959 only
Denotes limits of timing sections
0 10 20 30
Scale of yards

Fig. 2. Plan of Roundabout.

The observations made in September, before the erection of the signs, were at various times between 9 a.m. and 5.45 p.m. The April observations were made between 10.30 a.m. and 6.35 p.m., as it was thought desirable to obtain data for the period immediately following the afternoon peak period. For comparison of the before and after results only the data recorded between 11.15 a.m. and 5.45 p.m. have been used, although some of the results obtained during other observation periods have been included where it was thought that they might be of interest.

Measurement of Traffic Flow

Traffic counts were made during observation periods of 20 minutes, which were usually followed by a five minute rest period. Vehicles were divided into four classes as follows:

(*a*) Private cars and commercial vehicles not exceeding 30 cwt. unladen weight.
(*b*) Commercial vehicles of over 30 cwt. unladen weight.
(*c*) Public service vehicles.
(*d*) Motor cycles, motor scooters, mopeds and pedal cycles.

Totals were noted at the end of each minute's count.

Table I gives the mean flow (vehicles/h.) of traffic entering the roundabout by each approach during each 20-minute period, before and after observations combined. Table II gives similar details for each five-minute count during the peak period 4.35-5.45 p.m. Table III provides a direct comparison of before and after counts of vehicles entering the roundabout during the afternoon peak period.

Fig. 3. Roundabout viewed from Newport Road.

Observation of Driver Behaviour

Observations of driver behaviour were made at the same time as those of traffic flow. Behaviour was classified as follows:

(*a*) Driver entered the roundabout unimpeded.
(*b*) Driver gave way to a vehicle already on the roundabout.
(*c*) Driver caused vehicle already on the roundabout to give way to him (this behaviour is referred to in the text as 'taking way').
(*d*) Driver gave way to pedestrian on zebra crossing (this applied only to drivers approaching via Newport Bridge).

Vehicles were selected for observation as they passed a given reference point. After the observations on a particular vehicle had been completed, the next vehicle seen to pass the reference point was selected for observation. Table IV provides a summary of the results, divided in to 'off-peak' (11.15a.m.-4.30 p.m., and 'peak' (4.35-5.45 p.m.) behaviour.

Measurement of Journey Time

The vehicles selected for observation of driver behaviour were also timed through the roundabout, and the exit taken by each vehicle was noted. The sections over which the vehicles were timed, were, unfortunately necessarily rather short, as they had to be chosen so as to be visible to all the observers at their different observation points. The times recorded, therefore, give an indication only of the delays suffered by vehicles in their journeys through the roundabout, and do not give an indication of the delays in the approaches to the roundabout. In order to arrive at an estimate of the delays in what appeared to be the worst affected approach, throughout each peak period of the April observations cine-films were taken of traffic entering via Newport Bridge, pictures being taken at intervals of three seconds.

The mean off-peak and peak journey times through the roundabout are summarized in Table V. Journeys in which the driver took the first turning off the roundabout after entering it (i.e. simple left-hand turns) have been excluded from the calculations. The relationship between the length of one of the queues of traffic in Newport Bridge approach, and the mean time taken by the last vehicle in the queue to reach the entrance to the roundabout is shown in Fig. 8.

Pattern of Traffic Flow

The general pattern of the traffic flow may be obtained from the data in Tables I and II and also from Figs. 4, 5, 6 and 7. It was similar for both the September and April observations, but there was a small increase in the number of vehicles (excluding bicycles and motorcycles) passing through the roundabout during the peak period in April. The extent of this increase can be seen from the ratio of flows column in Table III.

(1) *Traffic arriving via Newport Bridge*

Between 11.15 a.m. and 4.30 p.m., mean flows were between 300 and 450 vehicles/h. (including cycles and motorcycles). After 4.30 p.m. the flow of cycles and motorcycles rose very rapidly from less than 100 vehicles/h. to a peak rate of more than 1,800 vehicles/h. between 4.40 and 4.45 p.m. It then declined, and after 4.50 p.m. fluctuated between 400 and 700 vehicles/h. until 5.45 p.m., after which it fell to less than 200 vehicles/h. The flow of other vehicles also rose from 4.30 p.m. onwards to a peak that usually occurred between 5.25 p.m. and 5.45 p.m., when the maximum rate of flow for a five-minute period

TABLE I

Mean traffic flows (vehicles/h.) into roundabout during 20-minute counts, 'before' and 'after' observations combined: peak and off-peak periods

Flows for cycles and motorcycles are in brackets

Start of twenty-minute period		*Approach*							
		Newport Bridge		*Newport Rd.*		*Ayresome Grange Rd.*		*Stockton Rd.*	
11.15 a.m.	off-peak	315	(35)	495	(60)	165	(30)	370	(30)
11.40 a.m.		310	(35)	490	(70)	165	(35)	345	(55)
12.05 p.m.		355	(80)	525	(170)	190	(60)	315	(50)
2.35 p.m.		270	(20)	575	(80)	230	(35)	335	(55)
3.00 p.m.		310	(55)	515	(55)	200	(15)	300	(30)
3.45 p.m.		305	(25)	585	(70)	200	(30)	290	(45)
4.10 p.m.		375	(55)	580	(140)	205	(50)	290	(50)
4.35 p.m.	peak	545	(1,160)	580	(365)	240	(50)	285	(60)
5.00 p.m.		645	(520)	700	(485)	310	(100)	270	(120)
5.25 p.m.		855	(455)	585	(275)	320	(95)	280	(75)
5.50 p.m.*		395	(115)	495	(180)	230	(85)	205	(80)
6.15 p.m.*		290	(65)	310	(115)	210	(55)	240	(80)

*These periods were used for observation purposes for the after studies only.

TABLE II

Mean traffic flows (vehicles/h.) into roundabout during five-minute counts, before and after observations combined: afternoon peak period (Flows for cycles and motorcycles are in brackets)

Start of five-minute period	Approach							
	Newport Bridge		Newport Rd.		Ayresome Grange Rd.		Stockton Rd.	
4.35 p.m.	570	(760)	500	(330)	235	(35)	305	(55)
4.40 p.m.	550	(1,870)	630	(515)	230	(55)	315	(45)
4.45 p.m.	500	(1,365)	575	(335)	240	(45)	255	(70)
4.50 p.m.	560	(645)	615	(275)	250	(60)	265	(70)
5.00 p.m.	515	(420)	665	(265)	295	(115)	310	(65)
5.05 p.m.	680	(505)	705	(595)	335	(85)	250	(120)
5.10 p.m.	745	(710)	720	(715)	315	(85)	280	(180)
5.15 p.m.	630	(440)	700	(370)	290	(105)	245	(115)
5.25 p.m.	790	(465)	590	(385)	355	(75)	275	(110)
5.30 p.m.	855	(645)	580	(230)	360	(100)	305	(75)
5.35 p.m.	930	(490)	530	(230)	310	(115)	260	(85)
5.40 p.m.	835	(215)	645	(250)	245	(90)	280	(45)

TABLE III

Vehicles entering roundabout during afternoon peak period; September 23/24, 1958, and April 21/22, 1959

Period	Approach used	No. of vehicles entering roundabout						Ratio of flows 1959:1958	
		Before observations			After observations				
		Date	Excluding cycles and motorcycles	Cycles and motorcycles	Date	Excluding cycles and motorcycles	Cycles and motorcycles	Excluding cycles and motorcycles	Cycles and motorcycles
4.35-4.55 p.m.	Newport Bridge	23.9.58	167	375	21.4.59	179	396		
	Newport Rd.	,,	217	106	,,	195	94		
	Ayresome Grange Rd.	,,	82	14	,,	66	17		
	Stockton Rd.	,,	77	17	,,	93	17		
	All approaches	,,	543	512	,,	533	524	0.98	1.02
	Newport Bridge	24.9.58	179	405	22.4.59	206	369		
	Newport Rd.	,,	177	141	,,	179	127		
	Ayresome Grange Rd.	,,	70	16	,,	80	14		
	Stockton Rd.	,,	106	19	,,	106	21		
	All approaches	,,	532	581	,,	571	531	1.07	0.91
5.0-5.20 p.m.	Newport Bridge	23.9.58	180	167	21.4.59	196	135		
	Newport Rd.	,,	246	140	,,	224	162		
	Ayresome Grange Rd.	,,	75	16	,,	93	39		
	Stockton Rd.	,,	82	22	,,	85	57		
	All approaches	,,	583	345	,,	598	393	1.03	1.14
	Newport Bridge	24.9.58	249	203	22.4.59	239	177		
	Newport Rd.	,,	224	214	,,	223	151		
	Ayresome Grange Rd.	,,	97	34	,,	101	41		
	Stockton Rd.	,,	83	38	,,	110	40		
	All approaches	,,	653	489	,,	673	409	1.03	0.84
5.25-5.45 p.m.	Newport Bridge	23.9.58	273	140	21.4.59	342	157		
	Newport Rd.	,,	193	100	,,	199	99		
	Ayresome Grange Rd.	,,	88	27	,,	94	38		
	Stockton Rd.	,,	88	15	,,	79	21		
	All approaches	,,	642	282	,,	714	315	1.11	1.12
	Newport Bridge	24.9.58	244	160	22.4.59	287	129		
	Newport Rd.	,,	164	95	,,	203	77		
	Ayresome Grange Rd.	,,	114	28	,,	98	33		
	Stockton Rd.	,,	101	23	,,	115	34		
	All approaches	,,	623	306	,,	703	273	1.13	0.89
All three periods	All approaches	23.9.58	1,768	1,139	21.4.59	1,845	1,232	1.04	1.08
	All approaches	24.9.58	1,808	1,376	22.4.59	1,947	1,213	1.08	0.08

was 800-1,200 vehicles/h. The April observations showed that after 5.45 p.m. the flow of these vehicles also fell sharply, to a figure of less than 400 vehicles/h. There was an increase, on April 22, to a flow of over 800 vehicles/h. between 6.15 and 6.35 p.m., caused by vehicles bound for the football ground at Ayresome Park, which is reached by way of Heywood Street.

(2) *Traffic arriving via Newport Road*

Between 11.15 a.m. and 4.30 p.m., mean flows were between 550 and 750 vehicles/h. (including cycles and motorcycles). After 4.30 p.m. there was an increase to a peak that was reached between 5.0 and 5.15 p.m. At this peak time the average flow of cycles and motorcycles was about 700 vehicles/h., and that of other vehicles was also about 700 vehicles/h. In one five-minute period on September 24 the flow of cycles and motorcycles rose to nearly 100 vehicles/h. There was some evidence in the April observations of a second peak at about 5.40 p.m. After 5.45 p.m. the combined flow fell to about 400 vehicles/h. between 6.15 and 6.35 p.m.

(3) *Traffic arriving via Ayresome Grange Road*

The mean flow was less than 300 vehicles/h. (including cycles and motorcycles) for most of the time, but rose between 5.0 and 5.45 p.m. to just over 400 vehicles/h. with peak flows (measured over a five-minute period) of up to 700 vehicles/h.

(4) *Traffic arriving via Stockton Road*

The mean flow was generally between 300-400 vehicles/h. (including cycles and motorcycles). There were a few short peaks of up to 550 vehicles/h. between 5.0 and 5.45 p.m.

It is evident from the data quoted above that the period of peak traffic flow through the roundabout occurred between 4.30 and 5.45 p.m.

Estimation of Flow in Weaving Sections

In order to form an estimate of the flow in the weaving sections of the roundabout it was necessary to know the proportion of the traffic in each weaving section that originated from each of the entrances to the roundabout. It was possible to estimate this proportion from the observations made during the measurement of journey times of a random sample of vehicles, as the entrance and exit used by each vehicle thus timed were noted. Thus the proportion of vehicles 'turning left', 'crossing', and 'turning right' could be estimated for each entrance. Since these observations were made over 20-minute periods, and since the total amount of traffic using each approach during each period was also known, the number of vehicles using each route could be estimated and a picture of the flow round the entire roundabout obtained. Table VI gives the estimated flows in the four weaving sections for the three 20-minute observation periods during the peak period 4.35-5.45 p.m. for the Tuesday and Wednesday before and after observations. The flows are given for cycles and motorcycles and for other vehicles. Because for most routes and periods the number of cycles and motorcycles in the random sample observed for journey time was very small, it was assumed that normally the four weaving sections were used by these vehicles in the same proportions as they were used by other vehicles. However, where the sample of cycles and motorcycles was large enough, the proportion using each route was estimated in the same way as for other vehicles. This means, in effect, that the figures in the table for cycles and motorcycles are not as reliable as those for other vehicles.

Table VI shows that the heaviest flows were in the Newport Bridge-Newport Road and Newport Road-Heywood Street weaving sections. Peak flows for vehicles other than motorcycles and cycles were slightly higher in the latter weaving section, being between 1,100-1,200 vehicles/h. in September 1958 and between 1,300-1,400 vehicles/h. in April 1959. Peak flows in the Newport Bridge-Newport Road section were about 1,100 vehicles/h. in September and between 1,200-1,300 vehicles/h. in April. For motorcycles and cycles the peak flow in the Newport Bridge-Newport Road section was similar in September and April, being between 1,200-1,300 vehicles/h.; in the Newport Road-Heywood Street section the peak value recorded in September was 1,150 vehicles/h. and in April, 1,360 vehicles/h.

TABLE IV

Summary of driver behaviour (excluding cyclists and motorcyclists) during off-peak (11.15 a.m.-4.30 p.m.) and peak (4.35-5.45 p.m.) periods before and after erection of signs

Ratio $\frac{G}{G+T}$ is the proportion of impeded drivers giving way to traffic already on roundabout

Approach	*Peak periods*						*Off-peak periods*					
	Before observations			*After observations*			*Before observations*			*After observations*		
	No. giving way $=G$	*No. taking way* $=T$	*Ratio* $\frac{G}{G+T}$	*No. giving way* $=G$	*No. taking way* $=T$	*Ratio* $\frac{G}{G+T}$	*No. giving way* $=G$	*No. taking way* $=T$	*Ratio* $\frac{G}{G+T}$	*No. giving way* $=G$	*No. taking way* $=T$	*Ratio* $\frac{G}{G+T}$
Newport Bridge	64	7	0.90	49	13	0.79	97	4	0.94	100	10	0.91
Newport Rd.	17	58	0.23	71	64	0.53[1]	36	20	0.64	42	63	0.40[3]
Ayresome Grange Rd.	50	2	0.96	75	12	0.86	104	6	0.95	136	10	0.93
Stockton Rd.	44	31	0.59	43	14	0.75[2]	78	51	0.60	67	25	0.73

[1]Change statistically significant at 0.1 per cent level
[2]Change statistically significant at 1 per cent level
[3]Change statistically significant at 5 per cent level

TABLE V

Mean journey times of weaving vehicles through roundabout (excluding motorcycles and cycles) before and after erection of signs

Approach	*Exit*	*Period*	*Off-peak periods* (11.15 a.m.—4.30 *p.m.*)				*Peak period* (4.35—5.45 p.m.)			
			No. of vehicles	*Journey time (secs.)*			*No. of vehicles*	*Journey time (secs.)*		
				Mean	*Standard deviation*	*Change in mean*		*Mean*	*Standard deviation*	*Change in mean*
Newport Bridge	Heywood St.	23/24.9.58	131	19.5	7.8		78	23.7	13.8	
		21/23.4.59	323	18.9	8.5	−0.6	123	21.9	8.4	−1.8
	Stockton Rd.	23/24.9.58	19	20.7	6.4		12	34.2	19.7	
		21/23.4.59	41	23.7	8.3	+3.0	24	29.8	12.7	−4.4
Newport Rd.	Stockton Rd.	23/24.9.58	201	12.7	3.9		81	19.0	13.1	
		21/23.4.59	428	12.9	4.5	+0.2	135	17.3	9.4	−1.7
	Newport Bridge	23/24.9.58	119	18.2	5.3		56	28.4	23.8	
		21/23.4.59	280	18.1	9.0	−0.1	107	24.0	9.0	−4.4
Ayresome Grange Rd.	Newport Bridge	23/24.9.58	123	17.9	10.9		78	26.9	19.6	
		21/23.4.59	394	15.7	7.8	−2.2	174	21.5	11.8	−5.4
	Newport Rd.	23/24.9.58	89	21.5	9.5		21	33.7	17.8	
		21/23.4.59	169	21.5	16.4	0.0	40	29.3	12.9	−4.4
Stockton Road	Newport Rd.	23/24.9.58	355	11.5	4.5		109	21.0	20.8	
		21/23.4.59	608	10.8	4.3	−0.7	181	16.3	9.8	−4.7
	Heywood St.	23/24.9.58	22	21.6	6.5		14	32.1	12.3	
		21/23.4.59	47	21.2	7.7	−0.4	12	24.0	6.6	−8.1

Flow diagrams for the roundabout given in Figs. 4 to 7 are derived from the data collected on April 21, 1959. They show:

(1) The flow pattern for the relatively quiet period 3.0-3.20 p.m.,
(2) The pattern for the period 4.35-4.55 p.m., when there was a sudden influx of cycles and motorcycles from Newport Bridge and
(3) The pattern for the period 5.25-5.45 p.m., when the roundabout was at its most congested.

As with the figures given in Table VI it should be emphasized that the patterns given for cycles and motorcycles (Fig. 7) are not of the same accuracy as those for other vehicles.

Composition of Traffic

The general composition of the traffic is shown in Table VII. The composition is given for the off-peak (11.15 a.m.-4.30 p.m.) and peak (4.35-5.45 p.m.) observation periods. The changes in the proportions of each type were similar on each of the five days on which the observations were carried out. They can be summarized:

(1) The composition of traffic during the off-peak periods was very similar on each of the four approaches, private cars and light commercial vehicles making up about 60 per cent of the total traffic and medium and heavy commercial vehicles between 20 and 25 per cent.
(2) Between 4.35 and 4.55 p.m. the proportion of motorcyclists and cyclists increased on all four approaches, the increase being large for vehicles arriving via Newport Bridge and Newport Road and small for the other two approaches.
(3) Between 5.0 and 5.20 p.m. the proportion of cycles and motorcycles in traffic arriving via Newport Bridge dropped somewhat, via Newport Road it remained about the same, and it continued to rise in traffic arriving by the other two approaches.
(4) Between 5.25 and 5.45 p.m. the proportion of cycles and motorcycles fell on all approaches, but still remained above the off-peak value. The proportion of private cars and light commercial vehicles rose to near the off-peak value, but that of medium and heavy commercial vehicles remained considerably lower.

Driver Behaviour

It is evident from Table IV that drivers tended to give way to a much greater extent when they approached the roundabout via Newport Bridge or Ayresome Grange Road than when using the other two approaches. The ratio of 0.9 (and over) impeded drivers giving way is very high, possible reasons being:

(1) Drivers arriving via Newport Bridge were descending the bridge approach and were probably decelerating rather more than is usual on approaching a roundabout. They may, therefore, have been more ready to give way.
(2) Drivers arriving via Ayresome Grange Road encountered at all times a flow of vehicles at least twice as great as their own. Conversely, vehicles arriving via Newport Road usually outnumbered those approaching from the right by a factor of two or three.

In addition to giving way to vehicles on the roundabout, drivers arriving via Newport Bridge sometimes gave way to pedestrians using the zebra crossing. The proportion doing so varied between three and 17 per cent of observed drivers. A driver giving way to a pedestrian on the crossing normally also gave way to any vehicle approaching from the right before he entered the roundabout. For this reason, these drivers have not been included in the totals of those giving and taking way shown in Table IV.

Effect of the Signs on Behaviour

The data given in Table IV for the numbers of drivers giving and taking way, before and after the erection of the signs, for both peak and off-peak

periods, have been compared statistically, with the following results:

(1) *Drivers entering via Newport Bridge*
There was no significant difference in behaviour in either peak or off-peak periods.

(2) *Drivers entering via Newport Road*
After the erection of the signs, significantly fewer (five per cent significance level) drivers gave way during off-peak periods. On the other hand, significantly more (0.1 per cent significance level) drivers gave way during peak periods.

(3) *Drivers entering via Ayresome Grange Road*
There was no significant difference in behaviour in either peak or off-peak periods.

(4) *Drivers entering via Stockton Road*
There was no significant difference in behaviour in off-peak periods.

After the erection of the signs, significantly more (1 per cent significance level) drivers gave way during peak periods.

Effect of the Signs on Journey Times

The mean off-peak journey times through the roundabout, before and after the erection of the signs, given in Table V, appear to be very similar, and no significant difference could be found between the

TABLE VI
Estimated flows in weaving sections during peak period

Weaving section	*Time*	*Estimated flow (vehicles/h.)*							
		Before observations				*After observations*			
		23.9.58		24.9.58		21.4.59		22.4.59	
		Excluding cycles and motorcycles	*Cycles and motorcycles*	*Excluding cycles and motorcycles*	*Cycles and motorcycles*	*Excluding cycles and motorcycles*	*Cycles and motorcycles*	*Excluding cycles and motorcycles*	*Cycles and motorcycles*
Newport Bridge-Newport Rd.	4.35-4.55 p.m.	780	1,190	830	1,280	770	1,230	970	1,180
	5.0-5.20 p.m.	810	570	980	700	890	590	1,050	660
	5.25-5.45 p.m.	1,100	470	1,100	570	1,280	560	1,230	500
Newport Rd.-Heywood Street	4.35-4.55 p.m.	1,050	880	770	1,150	770	1,360	940	1,160
	5.0-5.20 p.m.	1,140	790	1,120	1,120	1,070	790	1,150	850
	5.25-5.45 p.m.	1,190	600	960	650	1,320	770	1,380	630
Ayresome Grange Rd.-Stockton Rd.	4.35-4.55 p.m.	910	520	740	260	770	410	730	300
	5.0-5.20 p.m.	910	470	930	660	1,010	600	980	390
	5.25-5.45 p.m.	920	420	830	350	860	430	870	290
Stockton Rd.-Newport Bridge	4.35-4.55 p.m.	660	200	740	100	690	210	820	190
	5.0-5.20 p.m.	700	250	760	440	720	380	830	370
	5.25-5.45 p.m.	740	240	830	270	810	370	830	280

TABLE VII
Composition of traffic using roundabout

Approach	*Type of vehicle*	*Percentage of each type of vehicle*			
		Off-peak periods (11.15 a.m.-4.30 *p.m.*)	*Peak periods*		
			4.35-4.55 *p.m.*	5.0-5.20 *p.m.*	5.25-5.45 *p.m.*
Newport Bridge	Private cars and light commercial vehicles	60.0	22.5	45.0	55.0
	Medium and heavy commercial vehicles	25.0	7.5	7.5	7.5
	Public service vehicles	2.5	5.0	5.0	2.5
	Motorcycles and cycles[1]	12.5	65.0	42.5	35.0
Newport Rd.	Private cars and light commercial vehicles	57.5	42.5	45.0	52.5
	Medium and heavy commercial vehicles	25.0	12.5	7.5	7.5
	Public service vehicles	5.0	5.0	5.0	7.5
	Motorcycles and cycles	12.5	40.0	42.5	32.5
Ayresome Grange Rd.	Private cars and light commercial vehicles	60.0	57.5	55.0	60.0
	Medium and heavy commercial vehicles	20.0	17.5	10.0	10.0
	Public service vehicles	2.5	7.5	10.0	7.5
	Motorcycles and cycles	15.0	17.5	25.0	22.5
Stockton Rd.	Private cars and light commercial vehicles	60.0	57.5	52.5	55.0
	Medium and heavy commercial vehicles	20.0	17.5	10.0	12.5
	Public service vehicles	7.5	7.5	7.5	10.0
	Motorcycles and cycles	12.5	17.5	30.0	22.5

[1]Measurements taken from the cine film of traffic using this approach show a ratio of 185 bicycles to 100 motorcycles

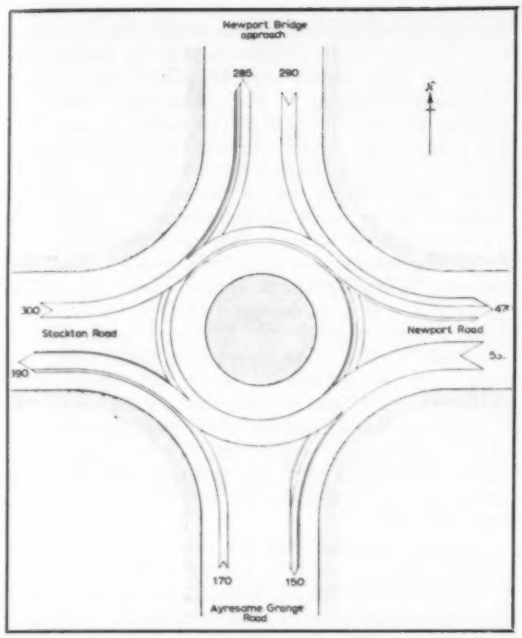

Fig. 4. 3 *to* 3.20 *p.m.* (*quiet period*). *Other than cycles and motorcycles.*

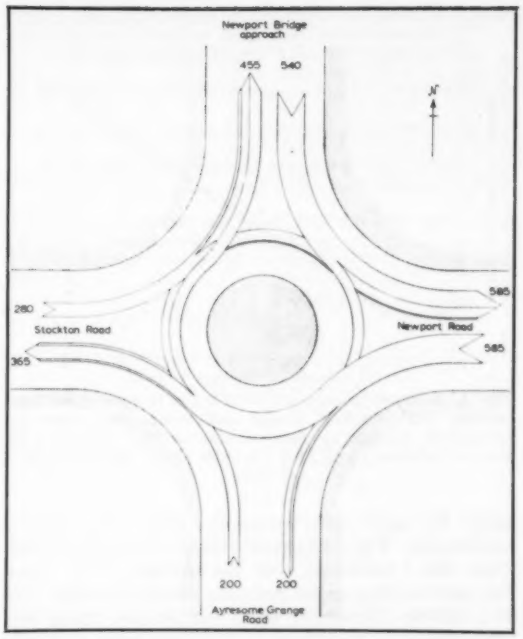

Fig. 5. 4.35 *to* 4.55 *p.m.* (*peak period*) *other than cycles and motorcycles.*

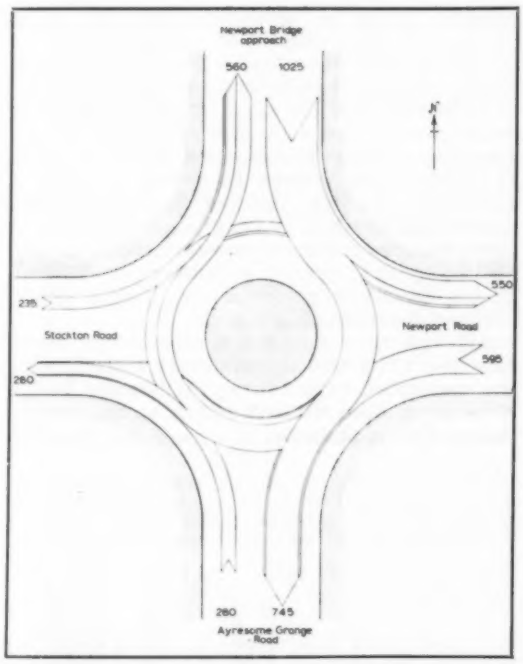

Fig. 6. 5.25 *to* 5.45 *p.m.* (*peak period*) *excluding cycles and motorcycles.*

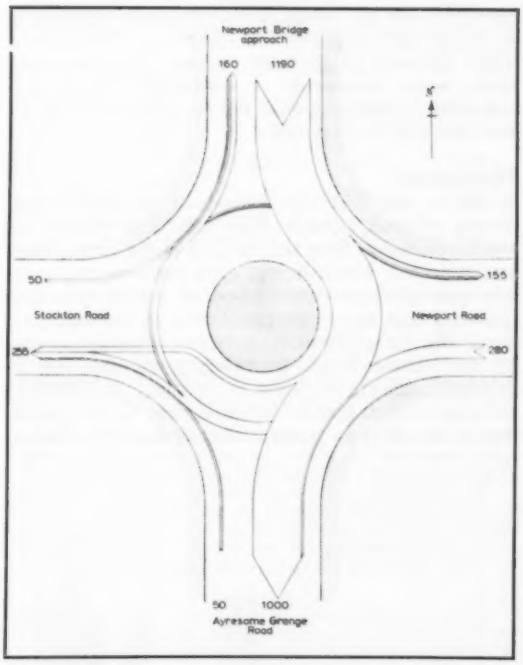

Fig. 7. 4.35 *to* 4.55 (*peak period for cycles and motorcycles*) *cycles and motorcycles only.*

Flow diagrams for the Roundabout derived from data collected on April 21, 1959 *for vehicles other than cycles and motorcycles* (*Figs.* 4, 5, *and* 6) *and for cycles and motorcycles only* (*Fig.* 7).

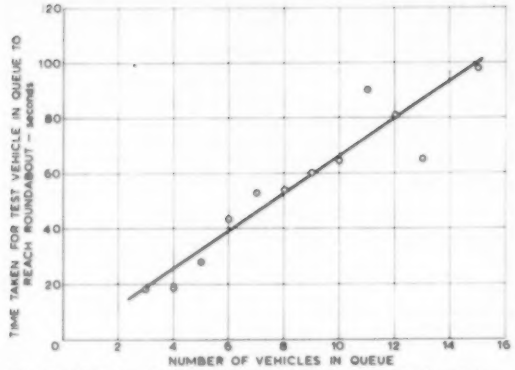

Fig. 8. Relation between length of queue in right-hand lane entering via Newport Bridge and mean time taken by last vehicle in queue to reach roundabout. Peak periods, 4.35 p.m. to 5.45 p.m. April 21 to 23, 1959, cycles and motorcycles excluded.

times for each route when the data were treated statistically. The mean peak journey times show that there was a reduction after the erection of the signs for each of the eight possible routes through the roundabout. However, when the journey times for each particular route were analysed the reduction was found to be statistically significant only for the times taken for the routes from Ayresome Grange Road to Newport Bridge, and from Stockton Road to Newport Road. When the journey times for each of the eight separate routes were combined and compared, the reduction was also found to be statistically significant at the 0.1 per cent level of significance. Moreover, when variances of the peak journey times for each route were compared, a statistically significant reduction in variance, after the erection of the signs, was obtained in every case.

Discussion

It can be seen from the analysis of the results that during off-peak periods there was little change in traffic conditions after the erection of the signs. This was expected, but is nevertheless encouraging, as it not only facilitates comparison of results but also indicates that any systematic errors in the observations due to differences between observers were probably small. Traffic conditions at the roundabout at these times are of course no problem; it is during the peak periods that severe congestion occurs, and it was in an effort to promote a freer flow of vehicles through the roundabout at peak periods that the signs were erected. Some changes occurring during the afternoon peak period were observed: there was a significant reduction in the mean time taken by vehicles to pass through the roundabout, and this was mainly due to the elimination of long delays (up to 2½ minutes) caused by locking of the roundabout; this is borne out by the smaller size of the variances of the April journey times (see Table V); the only occasion when locking occurred during the April observations was when two vehicles using the Newport Bridge approach were involved in a slight collision at 4.45 p.m. on April 23. The reduction in journey time during the afternoon peak period occurred in spite of an increase in traffic flow; the ratio of flows column in Table III shows that, excluding cycles and motorcycles, in the three 20-minute observation periods of the peak period there were increases of April traffic over September traffic of up to 13 per cent, and that over the peak period as a whole the increase was between four and eight per cent.

It is not possible to say how much of the apparent improvement in conditions at the roundabout was due to observation of the right-hand rule, as there may have been other factors contributing to the easier flow of traffic in April. For example, in both September and April there was some police control of traffic during the afternoon peak period. In September, the function of the police was mainly restricted to getting traffic on the move again after the roundabout had 'locked'. In April, police were mainly engaged in assisting groups of pedestrians over the zebra crossing, and in occasionally controlling traffic at the intersection of Newport Road and the roundabout. It should, perhaps, be mentioned here that the passage of pedestrians over the zebra crossing appeared, to some extent, to assist the flow of vehicles on the roundabout during the peak period, in that the influx of vehicles from Newport Bridge was periodically interrupted for a short time, enabling weaving traffic approaching from the right to proceed. On the other hand, the same pedestrian crossing tended to hinder vehicles trying to leave the roundabout for Newport Bridge, causing congestion in the Stockton Road-Newport Bridge weaving section.

Although there was an improvement in driver behaviour and a reduction in journey times through the roundabout, traffic entering via Newport Bridge or Newport Road was still subject to considerable delays. This is illustrated in Figs. 9 and 10 where

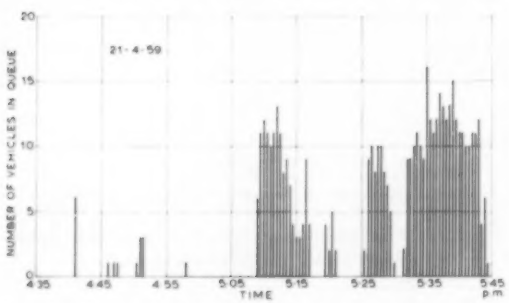

Fig. 9. Number of vehicles in queue in right-hand lane (excluding motorcycles and cycles) during peak period, Newport Bridge approach with queue length measured at 30 second intervals. April 21, 1959.

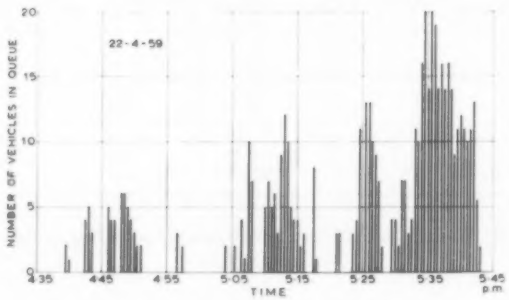

Fig. 10. The same for April 22, 1959.

length of the queues of traffic arriving via Newport Bridge are plotted. In order to obtain this data the number of vehicles in the queue in the right-hand lane was noted at intervals of 30 seconds between 4.35 and 5.45 p.m. It was not found possible to obtain similar data for the left-hand lane owing to buses stopping at the bus-stop and concealing vehicles behind them, but generally the queues in this lane appeared to be somewhat shorter. Results shown in Figs. 9 and 10 are for April 21 and 22, 1959. The pattern was similar on each day, the longest queues occurring between 5.30 and 5.45 p.m. From the information given in Figs. 7, 8 and 9 it is evident that, if an average queue length of ten vehicles is assumed, a vehicle entering the roundabout via Newport Bridge at the height of the evening peak period takes about 60 seconds to reach the roundabout after joining the tail of the queue. The additional journey time through the roundabout (see Table V) was about 22 seconds for vehicles leaving via Heywood Street and about 30 seconds for vehicles leaving via Stockton Road.

Conclusions

Driver behaviour

On two of the four approaches to the roundabout the proportion of drivers giving way to traffic on their right was very high at all times, both before and after the signs were installed. During the peak afternoon period of traffic flow there was a significant increase in the proportion of drivers giving way at the other two approaches after the installation of the signs.

Traffic flow

The general pattern of traffic flow was similar before and after the signs were installed; the April observations showed a small increase in the number of vehicles (excluding motorcycles and cycles) passing through the roundabout during the peak afternoon period. The formula developed by Wardrop[1] successfully predicted maximum flows in the two fully loaded weaving sections, in spite of their being short.

Journey times through roundabout

During off-peak periods there was no significant change in the mean journey times for weaving traffic through the roundabout, but during the afternoon peak period there was a highly significant reduction both in mean journey time and in the variance of journey times after the introduction of the signs. In spite of the improvement in journey times, delays in some of the approaches were still considerable—on one approach they were of the order of 60 seconds at peak periods—and if these delays are to be reduced the roundabout will have to be redesigned or replaced by something better.

APPENDIX

Capacity of roundabout compared with predicted values

Wardrop[1] has derived a formula for the capacity of weaving sections of roundabouts, which has been used to predict maximum flows in the weaving sections of this roundabout.

The maximum flow, Q, is found from the expression:—

$$Q = \frac{4.9\,(w + e)\,(41 - 3w)\,(3 - p)}{l\,(0.56 + h)} \text{ vehicles/h.}$$

where w = weaving width $(20 \text{ ft.} \leqslant w \leqslant 60 \text{ ft.})$
e = entry width $(12 \text{ ft.} \leqslant w \leqslant 60 \text{ ft.})$
l = weaving length $(w \geqslant 60 \text{ ft.})$
p = proportion of vehicles weaving $(p \geqslant 0.4)$
h = proportion of medium or heavy vehicles $(h \leqslant 0.25)$.

This formula assumes dry weather and the complete absence of pedal cycles. Wet weather is stated to reduce the value of Q by 10 per cent.

As can be seen from Fig. 1, in the case of this particular roundabout, determination of the values of w, e and l is rather difficult as three of the entrances have no islands. However the following values have been assumed:—

(1) Newport Bridge-Newport Road weaving section, e = 12 ft., w = 24 ft., l = 40 ft.
(2) Newport Road-Ayresome Grange Rd. weaving section e = 12 ft., w = 24 ft., l = 80 ft.
(3) Ayresome Grange Rd.-Stockton Rd. weaving section e = 18 ft., w = 24 ft., l = 40 ft.
(4) Stockton Rd.-Newport Bridge weaving section e = 16 ft., w = 24 ft., l = 40 ft.

It will be seen that except for section (2) the value of l is less than that allowed in the formula.

The expressions for Q, using the above values, then become:

for weaving section (1) $Q = \dfrac{388\,(3 - p)}{0.56 + h}$ vehicles/h.

" " " (2) $Q = \dfrac{547\,(3 - p)}{0.56 + h}$ "

" " " (3) $Q = \dfrac{453\,(3 - p)}{0.56 + h}$ "

" " " (4) $Q = \dfrac{431\,(4 - p)}{0.56 + h}$ "

The values of p and h for each weaving section have been determined for the period 5.25-5.45 p.m. on April 21. The resultant calculated values of Q and the estimated flows (from Table VI) are compared in Table VIII, below:—

TABLE VIII

Comparison of estimated flows in weaving sections with maximum flows predicted by Wardrop's formula for peak period 5.25-5.45 p.m. on April 21, 1959 (cycles and motorcycles excluded)

Weaving section	*Predicted maximum flow (vehicles/h.)*	*Estimated flow from observations (vehicles/h.)*
(1) Newport Bridge—Newport Rd.	1,200	1,280
(2) Newport Road—Ayresome Grange Rd.	1,500	1,320
(3) Ayresome Grange Rd.—Stockton Rd.	1,400	860
(4) Stockton Rd.—Newport Bridge	1,200	810

It can be seen that the predicted maxima are in quite good agreement with the estimated flows for weaving sections (1) and (2), even though the length of weaving section (1) was less than the minimum on which the formula was based. The other two weaving sections did not appear to be fully loaded.

Wardrop has stated that journey times increase rapidly when the flow exceeds 90 per cent of the maximum value. This is borne out by the queue length data for 5.25-5.45 p.m. for traffic arriving via Newport Bridge, given in Fig. 8.

It would appear that the presence of large numbers of motorcycles and cycles in the weaving sections (over 500 per hour in section (1) and over 700 per hour in section (2)) had little effect on the accuracy of the formula.

REFERENCE

[1] WARDROP, J. G. The traffic capacity of weaving sections of roundabouts. *Proc. 1st internat. Conf. on Operation Research* (Oxford 1957): English Universities Press. London 1957, pp. 266-80.

ACKNOWLEDGMENTS

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Origin and Destination Survey

GLASGOW'S URBAN MOTORWAY

by A. G. JURY

C.B.E., F.R.I.B.A., F.R.S.A., City Architect and Director of Planning

The Corporation of the City of Glasgow approved the first Quinquennial Review of the City Development Plan on June 23, 1960, and have submitted it to the Secretary of State for Scotland. Among the far reaching proposals is one for an urban motorway which was considered as essential after the traffic survey was undertaken and which is described here.

DESPITE the successful and widespread measures by the Corporation to combat congestion of traffic in the centre of Glasgow, delay and frustration persist. The cause has been the unabated increase in the number of mechanically propelled vehicles, which growth is still unchecked and is forecast to rise even further. It is clear that the remedial measures so far executed must be succeeded by a revised road system designed from the start to handle not only the present high traffic volumes but also the predicted increases.

Such comprehensive proposals must be formulated in the City Development Plan to ensure safeguards for securing the use of land for the roads and traffic network. These will also require to be programmed within a definite time to meet the demand and the City Architect and Director of Planning, the Master of Works and City Engineer and the Chief Constable were authorized to undertake a thorough investigation of traffic conditions in the central area in order to provide information on present volumes and directions, and to estimate the separate requirements for through traffic and stopping vehicles.

After considerable preliminary investigation, it was decided that the most feasible and economic study would be a 12-hour origin and destination survey. This required the setting up of 58 census points in a cordon completely surrounding the central area, and the recording of registration numbers of vehicles entering or leaving the centre. The pattern of movement could then be established by comparing the inward and outward records and by measuring the period elapsed or journey time.

Prior to the day of survey, the Planning Division of the Architectural and Planning Department undertook detailed pilot surveys which determined the best method of survey, the staffing requirements and the organizational techniques required to control the execution of the census. In addition, the opportunity was taken to gather useful supplementary information regarding the generation of traffic by different kinds of land use within the central area.

A Friday in summer was chosen for the survey because it was known from previous experience that the greatest volumes of regular week-day traffic would be counted, and on that particular date there would be no special conditions which would distort and make unrepresentative the observed traffic flow. The weather was mainly dry and cool. The survey was a 20 per cent sample of goods vehicles and cars, and the analysis was based on three-quarters of this figure, that is to say, a 15 per cent sample in order to save time in the analytical stage. Public service vehicles were excluded, since information was obtainable from the operators and this is to be the subject of a further report.

From the outset, it was apparent that it would be impossible to analyse the data by hand, and the survey was so designed that the second stage would be carried through by punched card processes. To do this the City Chamberlain, the General Manager of the Transport Department and the Master of Works and City Engineer made available the use of their machine sections, but in the event, nearly all the data processing stages were carried out in overtime since routine commitments absorbed the machine-time of normal working hours.

The survey involved over 6,000 man hours and a staff of 400 temporary employees. The immediate control of the teams was exercised from four muster points by students who had been employed for preliminary investigation and organization, and who had been specially trained to instruct the temporary staff with the aid of a lecture, duplicated instructions and a training film made in the Planning Division at very small cost. The high quality of the returns by the enumerators bore witness to this instructional success and the Corporation was well served by these temporary employees. The data processing of the survey involved 16 per cent of the man hours spent in survey which was a very economical proportion.

The report submitted to the Planning Committee presented the general conclusions which have been derived from an analysis of the survey results and indicates the nature of solutions to the traffic problem of central Glasgow. Much useful statistical data was compiled, from which diagrams accompanying the report have been drawn and which will be helpful in the detailed design of junctions and carriageways. (See Figs. 1, 2 and 3.)

Survey Analysis

The traffic volume disclosed by the survey was over 100,000 vehicle journeys operating through the survey cordon during 12 hours between 7 a.m. and 7 p.m. (100,000 journeys means 100,000 inward movements and 100,000 outward movements).

The analysis as shown in Fig. 1 gives the relative volumes of vehicular flow on the roads into the City Centre. The conclusions drawn from this analysis were:

(1) While the recognized main roads are very busy and most minor roads are much quieter, some minor routes carry almost as much traffic as important radials.

(2) The heaviest volume of traffic recorded on any road was just over 10,000 vehicles in the 12-hour period. This road (Alexandra Parade) thus caters for about 5 per cent of all the central area traffic.

(3) The important roads carry at least 4,000 vehicles per day, but to these figures must be added the total flows of buses and trams which are not shown in Fig. 1.

Fig. 1. Volume and direction of flow of private and commercial vehicles in thousands at the 58 census points.

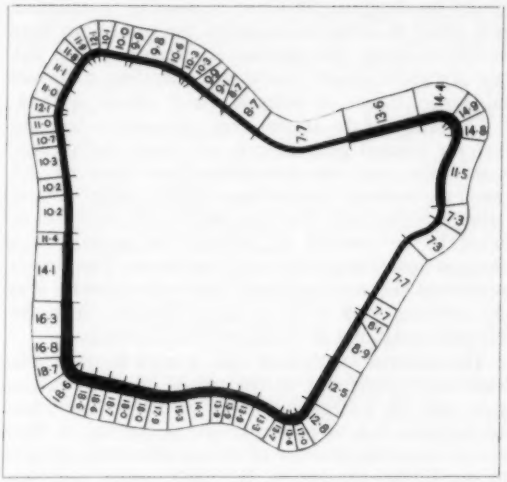

Fig. 2. Estimated 12-hour traffic flow on proposed inner ring road. The volume flow line is drawn through the census points and does not represent a road line either existing or proposed.

Without undertaking a lengthy and laborious analysis of each journey surveyed, it is not possible to be absolutely precise about the total quantity of by-passable traffic. Nevertheless, a useful analysis was undertaken by extracting from the journey records all those having a journey time of less than 30 minutes, since it was known that the longest through journey at peak periods was 35 minutes. This means that a few through journeys were missed but that the greater part of all by-passable traffic was extracted together with some short stopping traffic. This was considered to be a usable definition of by-passable traffic for the purpose of preliminary analyses.

By-passable Traffic

The information which was derived from the records showed place of entry and place of exit, and from the tables, which were prepared by machines, diagrams of the volumes and direction of flows were drawn. The broad picture is shown in Fig. 3 which gives only the directional flows of by-passable traffic, and was obtained by grouping the yield of several contiguous census points. It, therefore, does not represent the entire traffic flow but the proportion that was considered would by-pass the central area if a convenient alternative route was available. The most likely routes for point-to-point journeys were chosen to show the volumes of traffic by the width of the flow lines.

The survey indicated that about 50 per cent of the total traffic of the central area was by-passable, that is to say, it had no business to transact or other reason to come into the City Centre. Much of this traffic probably originates within the City, has a destination in or near the City and is not necessarily traffic between other towns and cities. The pronounced radial pattern of the main roads in Glasgow has the effect of focusing vehicle concentrations towards the core of the City, and this is further increased by the close positioning of the four road bridges over the River Clyde.

It was necessary to establish a relationship between the 12-hourly flow observed in the survey and the peak hourly flow upon which the capacity of a street

should be designed. While it is possible to examine each route in detail to establish the maximum flow which occurred, this method is cumbersome in the case of a major design. It is useful, therefore, to obtain an average figure or formula which can be applied.

The study of the survey data appeared to indicate that the inward peak flow is 1.6 times the average hourly flow, and that the outward peak flow was 1.8 times the average hourly flow. Other traffic surveys have provided data for comparison but the formula needs to be verified at intervals to measure any changes which might occur in the future. The survey confirmed the conclusions of previous censuses that the evening peak hour is more intensive than the morning peak, but is of slightly less duration.

The analysis confirmed that a very heavy traffic load was experienced on the streets of central Glasgow, and that a large number of vehicle journeys had no purpose but to pass through as quickly as they could. A certain amount of by-passable traffic sought to avoid the congestion by flank routes and this movement was itself a source of congestion. A relief route which provided improved river crossing and avoided causing congestion was necessary, and the analysis was made to establish the form and requirements of such a route. To establish whether the relief route should be drawn round the central area or should be a partial enclosure or a single by-pass on one flank, the volumes of by-passable traffic were calculated as if moving on a ring road (following the census point ring and not any carefully designed route). The purpose of this calculation was to establish by the varying volumes whether some flank had so little traffic as to make a new road unnecessary, which could easily be decided by noting those stretches where the volume was less than on a main road.

To estimate the traffic flow as shown in Fig. 2, a decision was made regarding each entry point volume as to whether vehicles would turn clockwise or anti-clockwise to reach the exit point. As was expected, the volumes which resulted from the calculation varied greatly, but it was also clear that on all sections of the route the volumes were sufficiently high to merit the construction of a major route.

The conclusions from this analysis were:

(1) The by-pass relief route must surround the central area completely.
(2) The most important section of the route was that requiring a new river crossing.
(3) The present maximum volume of traffic on the route would be over 18,000 vehicles every 12 hours, and the capacity of any proposed road should be based upon the foreseeable increase upon this figure.

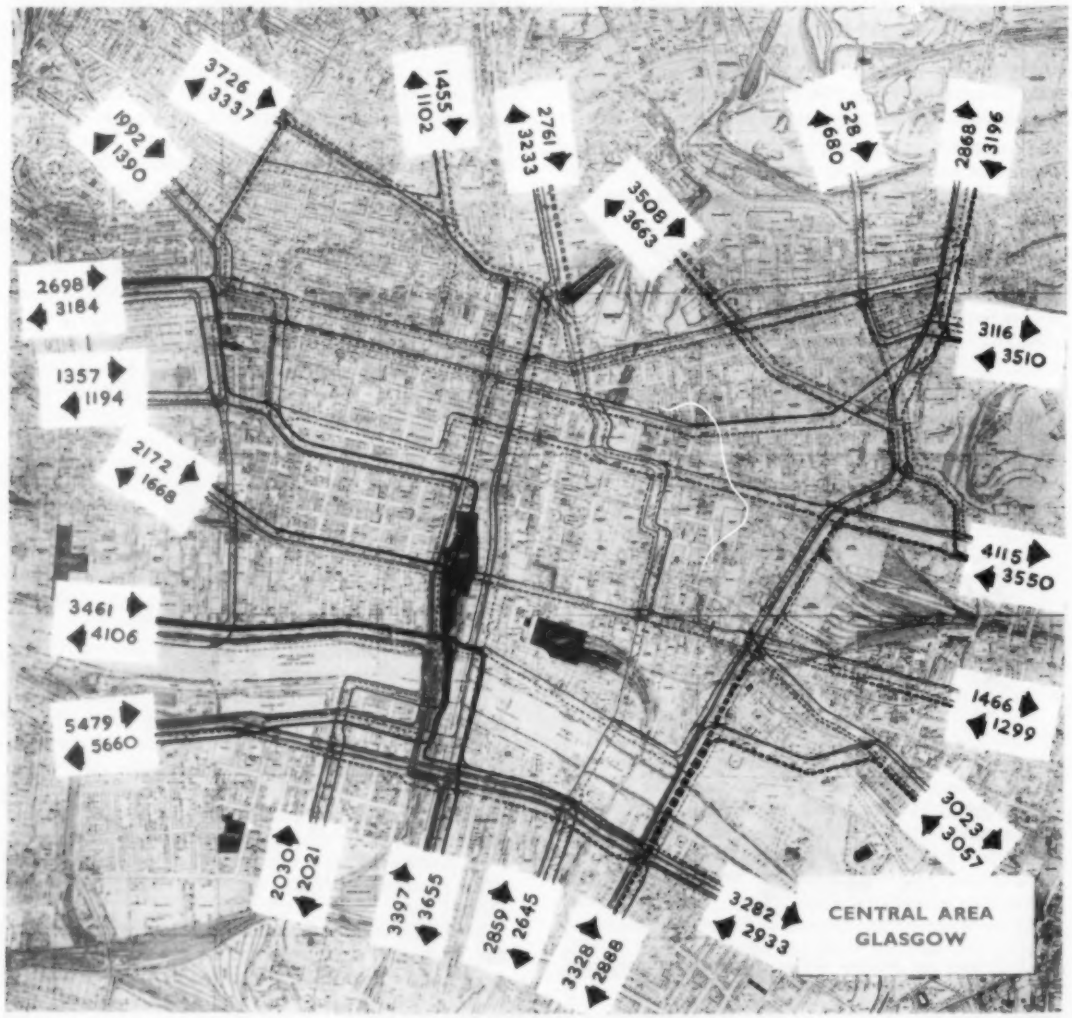

Fig. 2. Estimated volume of by-passable traffic. The flow lines show only by-passable traffic and not the entire traffic flow. Traffic originating on the South flank is indicated by solid red lines, on the North by dotted red lines, on the West by solid black lines and on the East by dotted black lines.

Two separate assessments of the volume of central area traffic were made and the results are complementary. The central area, or internal traffic, also includes public service vehicles which were not surveyed at this stage because their requirements are different from those of other vehicles and it was to determine parking needs and street requirements for these that the surveys were undertaken.

The first analysis was derived from the 12-hour origin and destination survey, and concerned the remaining 50 per cent of all traffic after extracting the by-passable volumes. It was estimated that the internal volume was about 50,000 vehicle journeys per 12 hours. The duration of their stay in the central area is given in Table 1.

The second source of information was a traffic generation sample survey of 460 firms interviewed prior to the origin and destination survey. The answers to questions were correlated with detailed information in area of floor space and use of accommodation already obtained by the Architectural and Planning Department. From these sources, estimates of the total vehicular generation of the central area were calculated and are shown in Table II.

There was considerable variation in the generation of vehicles by different use classes, for offices are more productive of car traffic, wholesale dealing is more productive of commercial traffic, and both generate more than industry or storage. The sample survey of traffic generation was used to establish an estimate of the working population and a total was arrived at of 150,000 persons in the survey area.

Analysis of the form of travel to and from work showed 6.1 per cent went by car, 1.3 per cent on foot and 92.6 per cent by public transport.

The conclusion reached from these analyses was that Glasgow was faced with four major problems affecting internal traffic in the central area:

(1) The long-term stopping vehicles were just over a third of the internal traffic of the central area. Their needs for off-street parking ought properly to be met within the curtilage of the premises which generate them because the greater part of the traffic was composed of private cars.

(2) The short-term stopping traffic was a larger total but much of this was in circulation. It was estimated that a parking provision equivalent to that of the long-term parking space would be sufficient for these vehicles since there would be a greater turnover. Since this cannot be made within curtilages, space must therefore be established in multi-storey parks, ground level sites or reserved parking streets.

(3) The public transport system was the most important mode of journey to work and must claim a priority in freedom of movement within the central area.

(4) Remedial measures to relieve by-passable traffic would free the City Centre streets but might be the cause of newly generated internal traffic particularly journey to work by car.

It was clear that the proposals for the requirements of internal traffic flows must involve not only the improvement of streets and the provision of parking spaces but the continued application of regulations governing off-street vehicle space provision and the parking restrictions to reduce or eliminate non-essential traffic on the main traffic ways. The importance of so doing was pointed by the fact that about 25 per cent of the working population of the City was

TABLE I

Duration in Central area (i)	*Estimated Total Vehicles* (ii)	% (iii)	*Cars* (iv)	% (v)	*Goods Vehicles* (vi)	% (vii)	*Group %* *Cars* (viii)	*Group %* *Goods Vehicles* (ix)
Up to 1 hour	17,000	34.0	9,604	19.2	7,413	14.8	37.0	25.4
Up to 2 hours	14,250	28.5	8,942	17.8	5,282	10.6		
Up to 3 hours	6,600	13.2	4,516	9.0	2,101	4.2		
Up to 4 hours	4,100	8.2	3,206	6.4	907	1.8		
Up to 5 hours	2,500	5.0	2,003	4.0	478	1.0		
Up to 6 hours	1,400	2.8	1,187	2.4	214	0.4		
Up to 7 hours	800	1.6	676	1.4	148	0.3	29.1	8.5
Up to 8 hours	850	1.7	742	1.5	132	0.3		
Up to 9 hours	1,500	3.0	1,327	2.7	124	0.2		
Up to 10 hours	800	1.6	701	1.4	91	0.2		
Up to 11 hours	200	0.4	181	0.3	25	0.1		
	50,000	100.0	33,085	66.1	16,915	33.9		

The figures in columns viii and ix are separated into short-term stopping traffic and long-term stopping traffic. The parking provision for the latter is that which should be provided within the curtilage of premises as required by the Central Area Planning Regulations for new development. While the figure of over 31,250 vehicle journeys which were short-stopping in the city centre is an enormous burden, the long-term stopping traffic (over a third of the whole) is also a serious problem.

TABLE II

Vehicle generation by central area floor space accommodation

		Total
(i)	Number of cars used for journey to work in City Centre	8,883
(ii)	Goods vehicles operated from City Centre addresses	7,257
(iii)	Total cars used for business purposes by City Centre firms (this includes (i) above, cars of travellers, etc., who do not work on the premises of firm but call in, and car pool vehicles not used for journey to work)	17,837
(iv)	Total calls per day made by goods vehicles for collection and delivery (this includes a proportion of (ii) above)	31,492

employed in the central area, the efficient function of which was threatened by congestion and delay.

Estimates of the local growth of traffic in the foreseeable future were particularly difficult and were not undertaken in the preparation of the survey or report, but if the national traffic volumes increase by 300 per cent in 15 years, it would be unwise to assume that the by-passable traffic coming to the central area would increase at a lower rate. This led to the conclusion that the relief road system enclosing the central area should be capable of carrying up to 54,000 vehicles per 12-hour day.

Conclusions reached were as follows:

(1) The undertaking of the traffic survey was extremely useful in providing information from which realistic deductions could be made, and it provided a sound basis for the calculation of capacities and traffic requirements of existing and future road systems.
(2) The high proportion of by-passable traffic indicated that a relief road was required.
(3) The calculable volumes of traffic led to the conclusion that the relief route should enclose the central area.
(4) The volume of traffic which would use such a route might now be as high as 18,000 vehicles per 12-hour day on any section. This might well rise to 54,000 in 15 years time.
(5) Conflict between by-passing flows and radial flows continuing into the central area was likely to be severe and consideration of the high volumes as well as the other factors (economy in land, freedom from accident, and construction costs) might lead to the conclusion that a 'through-way' system with grade separation at intersections was the best solution.

The effect of providing an adequate relief route for through traffic might halve the present burden on the central area streets, but this gain might be offset by newly generated traffic and almost certainly by the estimated future increase. Nevertheless, the penalty which might be incurred by not providing such a system was likely to be persistent and growing congestion by essential vehicle users with a consequent deleterious effect upon the vitality of central area functions which employ about 150,000 persons, or slightly more than 25 per cent of the total employed persons in the City of Glasgow.

Within the central area the provision of adequate parking standards both within curtilages for the long-term parker and outside curtilages for the short-term parker, must be seriously considered. The expense of this provision might be high in the first instance, but since a long-term view of traffic congestion and volumetric increase must be taken, the costs would need to be measured over a long period of years and compared with the cost to a city and the property owner in a city centre which was stifled and devitalized by an inefficient communication system.

1960 Quinquennial Review Proposals

The Corporation, having considered a joint report of a technical and administrative working party consisting of Government technical officials, the Master of Works and City Engineer and the City Architect and Director of Planning and in the light of the Report on the Traffic Survey of the Central Area carried out in August 1958 by the City Architectural and Planning Department, concluded that:

(1) Having regard to the anticipated increase in the volume of traffic in the next 15 years, an inner ring road will be essential for the City.
(2) The said road will require to be of the scale and purpose of an urban motorway rather than a multi-purpose traffic road because,
  (i) its primary purpose will be to divert traffic away from the central area, and it would therefore require to separate by-passable traffic from traffic having a purpose in the central area;
  (ii) it must therefore consist of a major ring route having dual carriageways with a design offering no impediment to the rapid movement of through traffic;
  (iii) it must have grade separated junctions to solve the conflict at junctions between traffic flowing into the central area and the by-pass traffic using the inner ring road itself;
  (iv) it must not impede the secondary approach routes to the City Centre, which must therefore pass under or over the ring road without connection so permitting the free re-distribution of traffic having business in the central area;
(3) that the construction of the entire road, including a proposed new bridge over the River Clyde on the line of Clyde Ferry Street/Shearer Street, should, if possible, be completed within the next ten years.

Appointment of Consultants

The Corporation have appointed the following consultants to advise them on the execution of the project:

Architectural and Planning
Professor Sir William Holford, P.R.I.B.A., P.P.T.P.I.
Traffic Engineering
Messrs. Scott & Wilson, Kirkpatrick & Partners
Economics and Land Values
Mr. A. T. McIndoe, A.R.I.C.S., M.T.P.I., and Mr. Donald J. Robertson, M.A.

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next month . . .

Traffic Planning in Sweden
Erik Hasselquist
Chief Inspector, National Board of Roads

American Report—Driver Education and Rehabilitation
Francis S. McGlade
National Commission on Safety Education

Scientific Approach to Urban Traffic Problems
W. Fisher Cassie
Professor in Civil Engineering, University of Durham

Instruments for Traffic Engineers, No. 5. Acceleration, Deceleration and Fuel Consumption
B. D. Richardson
Lecturer in Highway and Traffic Engineering, University of Birmingham

Roundabouts versus Traffic Signals
Report of Discussion at Traffic Engineering Study Group

Profile of Kenneth Summerfield
County Surveyor, Oxfordshire

American Report

EXPERIENCE with TRAFFIC SIGNALS

by Burton W. Marsh and William L. Carson
Traffic Engineering and Safety Dept.
American Automobile Association

Fig. 1. Master control unit of the recently installed Pro Rata traffic signal system in Los Angeles.

THE first electric traffic control signal in the United States was installed in Cleveland, Ohio, in 1914. Since then, the usage of this device for controlling vehicle and pedestrian movements has grown rapidly and widely, and there are now few urban areas that do not have at least one in operation. Through the years, numerous improvements and refinements have been made in signal equipment—two major ones being the development of traffic-actuated signals and of signal systems that can be remotely controlled by radio.

The term 'traffic control signal' is normally defined as 'any device whether manually, electrically or mechanically operated by which traffic is alternately directed to stop and permitted to proceed.' For purposes of this discussion, however, 'traffic control signal' will refer only to the standard, green-amber-red electric traffic lights.

Purpose and Value

Electrically operated traffic control signals have proved to be valuable devices for controlling vehicular and pedestrian traffic and for effecting safe, efficient traffic flow. When properly designed, applied, located and operated, traffic control signals will normally:

(1) Improve the orderliness of traffic movements;
(2) alleviate crossing problems of vehicles and pedestrians along heavily travelled streets and highways;
(3) reduce the frequency of certain types of accidents, and
(4) in groups, help make it possible to control the rate of vehicle travel along particular highways and streets.

In addition, these devices are generally much more economical than manual control at those intersections requiring alternate assignment of the right of way. As will be noted later, however, these benefits are obtained only when utilization of traffic control signals is warranted and justified.

Following are some specific examples of how the installation of traffic control signals, or improvements in their operation, have produced significant benefits in various United States communities.

In Cincinnati, Ohio, (pop. 494,883), installation of traffic control signals at the intersection of a two-way street with a one-way street reduced the frequency of accidents at the intersection by 60 per cent, injury and fatal accidents by 80 per cent. Previous to the installation of signals, the intersection was controlled only by STOP signs on the two-way cross street. After studies by Cincinnati's traffic engineers had indicated justification of signalization on the basis of traffic volumes and speeds and seriously restricted sight distances, a pre-timed traffic signal was installed, along with pedestrian signals for each cross-walk. During the five years prior to installation of the signals, an average of 19.8 accidents, including 4.8 injury and fatal accidents, had been experienced at this intersection each year. In the three years following installation, the average was 7.8 accidents, including 0.3 injury and fatal accidents. Moreover, the signals created little interference with the free flow of traffic, having been timed in accordance with traffic volume patterns and co-ordinated with other nearby signals.

Douglas Carmody, Director of Parking and Traffic for Modesto, California, (pop. 36,099), reports that modernization of seven out-dated traffic signal installations along a major route in that city reduced the number of accidents at the intersections involved by almost one-half. The modernization consisted of the installation of red-emphasis mast-arm signals (12 inch red, 8 inch amber and green indications),

some additional post-mounted signals, and improved signal head arrangements. The total cost of modernization was $21,770 but, as shown in Table 1, property damage savings in the first year following the improvements were more than half this amount.

TABLE 1
Traffic Signal Modernization
(Modesto, California)

	1 *year before*	1 *year after*	*Change*
Total Accidents	115	76	Down 49%
Right Angle Accidents	61	10	Down 83%
Other Vehicle-vehicle Accidents	50	64	Up 22%
Vehicle-pedestrian Accidents	4	2	Down 50%
Fatalities	0	1	Up 1%
Injuries	34	20	Down 41%
Property Damage	$38,318	$26,724	Down 30%

Fig. 2 indicates the improvement in the accident situation at one of the intersections involved. Note that 9th Street was also made one-way.

Benefits of Modernization

Modernization of a traffic control system in Cincinnati, Ohio, also produced notable benefits to traffic movement and safety. On one of its most heavily travelled thoroughfares, a completely remodelled traffic signal system was installed along a four-mile section, under the supervision of the Director of Public Utilities and Traffic, George W. Howie. The original signal system had consisted of one three-section signal head mounted horizontally at the far right corner for each traffic approach to 23 signalized intersections. The signal equipment was in poor physical condition and visibility of the signals was inadequate. Modernization included provision of two signal faces facing traffic approaching intersections on the major street, plus pedestrian signals for each cross-walk across the main street at signalized intersections. In addition, certain improvements were made in the type of signal controllers used, a number of channelizing islands were installed at T intersections, and the centre line was shifted on certain sections of the street so as to provide for unbalanced traffic flow.

Studies by Cincinnati traffic engineers before and after the improvements revealed the following:

(1) The practical traffic capacities at the three principal intersections were increased by an average of 13 per cent, and at several other intersections by as much as 30 per cent.
(2) Despite a 10 to 15 per cent increase in traffic volumes, the average trip along the section of street involved required 7.5 per cent less time.
(3) Total accidents at the 23 signalized intersections decreased from 448 during the year before the improvements to 354 in the year after, a reduction of 21 per cent. Injury and fatal accidents at these intersections decreased 20.3 per cent (64 to 51) during the same period.
(4) Savings in time, vehicle operating costs, and accidents have been estimated at $140,000 per year, nearly 65 per cent above the total installation cost of some $85,000.

There was installed in the Downtown area of Los Angeles, last September, what is claimed to be the latest and most advanced all-electronic system of radio co-ordinated traffic signal control. This Pro Rata traffic control equipment provides automatic preferential treatment for the direction of heaviest traffic demand. In the morning hours when the greatest traffic volume is in the downtown direction, this inbound traffic is given relatively long green signals and the time relationship between signals at adjacent intersections provides a smooth progression in the downtown direction. In the afternoon, when the predominant traffic is outbound, preferential treatment is given to movement in the opposite direction. During hours of average and light traffic, the computers dictate a suitable balanced traffic pattern so that neither direction is favoured.

Radio Control

The necessary electrical information is transmitted via microwave radio link between widely separated radar detection devices and a master control unit in the City Hall and traffic signal controllers at the 36 signalized intersections. Vehicles moving into the Pro Rata system at either end are sensed and counted by radar detectors suspended over the roadway or by pressure pads in the pavement. Traffic flow information obtained by radar is converted to electrical impulses and transmitted by radio to the master control unit. This information is continuously and automatically analysed by electronic computers in the master control unit which then selects the traffic signal pattern which assures the most efficient movement of traffic for the controlled area. Electrical operating instructions are beamed from the tower antennae of City Hall via microwave radio link to receiving and decoding equipment in MacArthur Park, and from there relayed to the local signal controllers at each of the intersections. (See Fig. 1.)

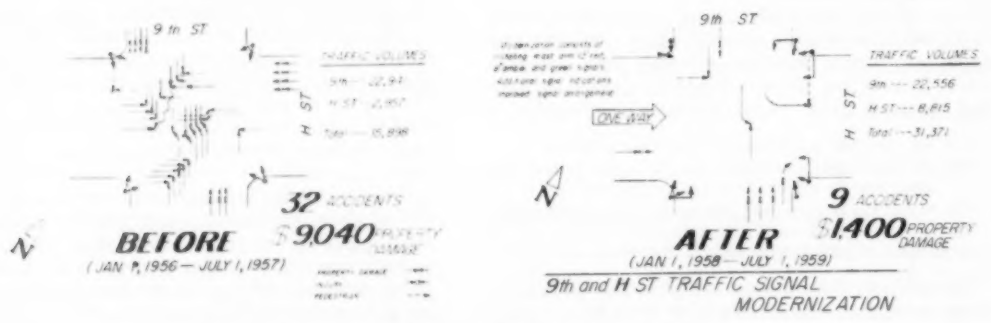

Fig. 2. Comparison of accidents and damage before and after signal modernization, Modesto, California.

In Austin, Texas, (pop. 185,052), Traffic Engineer Walter H. Klapproth reports that replacement of standard, 8 inch signal lenses with 12 inch lenses reduced traffic accidents at certain intersections. In all, 255 red, yellow, green, and green-arrow 12 inch lenses were installed at 17 intersections, along with 98 new 8 inch lenses for less important lenses. In the year following installation of the new lenses, 21.6 per cent fewer accidents occurred at the intersections involved compared with the average for the previous two years, 98 as against 125. Traffic authorities in Austin feel that the significant reduction in the number of intersection collisions has been well worth the small additional cost of larger lenses. They have, therefore, established a policy of using 12 inch lenses for all primary indications with, in some cases, 8 inch lenses at supplementary locations.

At a major intersection in Spokane, Washington, (pop. 180,882), the frequency of accidents seemed abnormally high. Field studies revealed that existing traffic control signals, mounted at corners of the intersection, were hard to detect because of commercial neon signs in the background. Under the direction of City Traffic Engineer Elmer J. Leland, the signals were remounted on 20 foot mast arms extending over vehicular traffic lanes. Before and after studies showed that while 19 accidents had occurred at the intersection in a 10 month period before the signals were remounted, 10 accidents took place in a like period after the changes, a reduction of approximately 47 per cent.

Signal Timing and Co-ordination

Modifications in the signal timing at an intersection in Richmond, Virginia, (pop. 218, 486), at a relatively small cost, more than paid for itself in accident reductions. Accident records indicated that an unusually high number of accidents were occurring at the intersection and that, in many instances, one of the drivers involved had been moving against a red signal indication. The signal change period (green to amber to red) was therefore increased by several seconds and an all-red clearance interval of approximately three seconds following the amber indication on both phases was provided. As shown in Table 2, this modification in signal timing produced substantial accident reduction at a cost of only $350 for equipment and labour.

TABLE 2
Signal Timing Change
(Richmond, Virginia)

	14 mos. before	*14 mos. after*	*Reduction %*
Accidents	31	14	55
Injuries	30	4	87
Property Damage	$12,055	$5,415	55

Traffic engineers in Atlanta, Georgia, (pop. 484,825), improved both the efficiency and safety of traffic movement along a busy street by co-ordinating traffic signals at its nine intersections. Previously, with an alternate signal system (wherein alternate intersections show red and green indications along a given street at the same time) ten minutes was required to travel a one mile length of this street during the peak traffic period. By engineer designed co-ordination of signals, travel time for the peak period was reduced to four minutes and the number of accidents during the year after the change was 30 per cent less than that for the year before, 99 as compared with 142.

As has been shown, traffic control signals can be beneficial if properly applied and used. However, they do not automatically improve safety nor are they necessarily the answer to an intersection control problem. As is true for other traffic control devices, signals should be installed only if factual studies and professional judgment indicate that conditions are such that the signals will be beneficial and are justified. If unwarranted, traffic control signals may well result in:

(1) Excessive and unnecessary vehicle and pedestrian delays.
(2) A high degree of non-observance.
(3) Undesired shifting of vehicular traffic to uncontrolled streets.
(4) Increased accidents.
(5) Waste of limited traffic improvement time and money.

Experience in the United States has shown quite clearly that traffic control signals can do more harm than good if they are not applied properly. In one instance, stop signs were replaced with traffic control signals at a semi-rural intersection in an Eastern state despite the fact that the signals were not warranted by traffic conditions and that traffic engineers had opposed their installation. During the 15 months following installation, three times as many accidents occurred as had taken place during the 17 months before (19 as compared with six), with resultant property damage increasing from $1,670 to $11,105.

Similarly, in a small community in the Western part of the United States, 40 accidents involving eight injuries occurred in the year following installation of semi-actuated traffic signals at an intersection, as compared with only 12 accidents involving five injuries that took place in the preceding year.

Conclusion

The above examples illustrate the significant effects on traffic movement and safety which traffic control signals can produce. It is apparent, however, that if these effects are to be beneficial rather than detrimental, determination as to signal installation and operation must be based upon factual study and sound professional judgment. Traffic control devices need to be employed judiciously and properly if their values are to be realized. For United States conditions, minimum justification developed for traffic control signals, on the basis of experiences with such devices, and set forth in the Manual on Uniform Traffic Control Devices, provides safeguards against serious mis-application. It would seem that some such justification would be desirable in other places since unfortunately not all traffic control devices are installed only after thorough study by informed traffic engineers. Any installation of signals at locations where such justification is not met should be only after a careful study of existing conditions indicates that the situation is unique, and only after an experienced traffic engineer has decided that the device is, for special reasons, warranted.

In all instances, it is desirable to make studies after signals have been installed so as to ascertain effects and possible need for modification, and also to increase knowledge and professional competence. Traffic control signals can contribute importantly to improved traffic safety, but only if they are designed, applied and operated properly.

On the left is a view of tunnellers in action in one of the two new road tunnels at Wyllie's Poort in Transvaal, South Africa. Below is shown Wyllie's Poort Gorge, where two years ago, the road and foundations were washed away by floods. Photographs by Atlas Copco Ltd.

DEVELOPMENTS

Below: The George Washington Bridge, New York, showing the recently completed lower deck.

On the right is the AASHO road test. For two years trucks carrying various weights have been running for 19 hours a day six days a week, in the most complete road test ever made. This test is now completed and below shows the information being analysed.

ILLUSTRATED

Below: The George Washington Bridge at dusk. Photographs by the Port of NewYork Authority.

Road Research Laboratory

COURSES ON TRAFFIC AND SAFETY

by W. S. O. Scott, B.Sc., A.R.C.S., D.I.C., F.Inst.P., Assoc.I.C.E.
Road Research Laboratory

THE results of research and experiment on roads and road users are of only limited value if they are not made readily available to highway engineers and others concerned with road problems. It is, therefore, an important part of the Road Research Laboratory's activities to take steps to make the results of research readily available and as widely known as possible.

In addition to the publication of results printed in a variety of forms, papers to learned societies, open days and other exhibitions, results are publicized by short courses which are held each year at the Laboratory. Special reference is made in the following account to those which are now regularly given at the Traffic and Safety Division.

Dealing with publicity in the printed form, two series of official publications —Road Notes and Technical Papers— are printed for the Laboratory by the Stationery Office. The former generally give practical recommendations on specific aspects of road construction, maintenance or usage, whilst the latter usually consist of detailed accounts of theoretical and/or experimental investigations on subjects of wider scope. These series are constantly being added to, and have been supplemented by the books 'Soil Mechanics for Road Engineers' and 'Concrete Roads: Design and Construction' (other books will follow), and by the Annual Reports of the Road Research Board. Technical articles are published in a wide selection of technical journals under the authorship of members of the Laboratory staff, whilst papers are presented to the various institutions and societies concerned with road construction and usage. The monthly publication, 'Road Abstracts', provides a world-wide coverage of the literature for those wishing to keep abreast of developments in respect of highway construction and use.

In addition to publicity in printed form, the Laboratory has organized each year since the war a series of short courses, held during late autumn and early winter at the Materials and Construction Division. In recent years, these courses have occupied a period of 12 weeks from the end of September to shortly before Christmas; each course runs into two weeks, and occupies a period of six to nine working days. The session normally consists of six courses, two on each of the three principal classes of engineering practice associated with road construction, viz., soil mechanics (as applied to road foundations), bitumin ous (including tar) materials, and concrete roads.

In 1951, following a suggestion from the Institution of Municipal Engineers that the Laboratory might give courses in traffic engineering, a two-day general conference on traffic engineering was held at the Laboratory in April, and was attended by some 45 representatives of interested bodies, such as professional institutions and societies, major highway authorities, government departments, the universities and the police. The conference agreed that it would be valuable if the Laboratory could organize courses, and this recommendation was endorsed by the Road Research Board.

As a result, the first Road Traffic and Safety course was arranged for February, 1952. It occupied five working days, and the items dealt with comprised the measurement of traffic behaviour, traffic capacity and regulation, censuses, signs, parking, road layout and accidents, surface characteristics (skidding and riding quality), street lighting, accident data, police aspects and the use of statistical methods, which find applications in almost all considerations of traffic and accident data. For certain items, the lectures were given by members of the Ministry of Transport staff, and one lecture was given by a police official. For the second course, held in March 1953, it was found possible to manage without calling on outside assistance.

It is obvious that the police, as well as highway engineers, have an essential part to play in traffic and safety matters. The first two courses included only one or two representatives of police forces, but, after circulating the particulars in advance to Chief Constables, the police representation amounted to nearly 30 per cent of the course membership in 1954, and has remained at 20 to 30 per cent in all subsequent courses. The fact that the police necessarily exercise a special function in traffic and safety matters, though different from that of the highway engineer, has prompted suggestions that the Laboratory might organize a separate course for police officials alone. However, the general feeling of the police representatives was definitely against a specialized course, since their appreciation of the factors which affect road conditions and characteristics, and their understanding of the highway engineers' problems was greatly enlarged by full participation in all the lectures and discussions included in the course. Conversely, the highway engineers were in no doubt that they had much to learn from the police point of view and not least from the keenness with which police officials endeavour to promote road safety and of their great interest in schemes for educating all classes of road users in the best kinds of road behaviour. In certain cases, engineers and police from a given area have found it convenient and advantageous to attend the same course together.

Suggestions have been made that separate courses, or possibly separate lectures, might be given for engineers working with county authorities and for those concerned with urban areas. It was agreed, however, that such segregation would be disadvantageous since, although the application of given results or methods to the somewhat differing conditions of rural and urban areas may involve rather different treatment, the underlying principles are a common factor. In any case, most highway engineers enlarge their experience by transferring from one authority to another, and often move from rural to urban authorities or vice versa, so the joint participation of rural and urban representatives in the proceedings is of mutual advantage.

After the first course on traffic and safety it was evident that rather more time was desirable, so the second and subsequent courses have occupied seven working days beginning on a Tuesday. March has been generally agreed as convenient a time as is practicable because at that time highway engineers have usually completed compilation of the annual estimates, whilst the season of heavy activity on road construction and maintenance is not yet fully under way.

Although each of the first four courses was attended by almost entirely different personnel, the total response remained static at around 35 members. During the years after the war, however, road traffic had steadily increased, whilst the capacity of the road system remained virtually unaltered. In con-

sequence, from 1955 onwards, a rapidly increasing awareness of the acuteness of traffic and safety problems resulted in corresponding rapid increases in the demand for places at the course. The Laboratory took over 50 members on the 1956 course, but it was evident that two courses would be required in 1957. In 1959, the demand far outstripped the capacity of 100 for two courses, and a third course was added, which was also filled to capacity. In 1960, the demand exceeded the capacity of the three courses which had been planned and announced, but it was felt that no further expansion was possible. In consequence, a selection of the applicants had to be made in the light of the extent of previous or recent representations which the authorities concerned had had as to size and the existence of any special circumstances, such as impending major works or replanning in the areas concerned.

The Student Body

The majority of the constituent personnel on the courses are highway engineers and police representatives from both county and urban areas. They are expected to be senior officers or to be specially concerned with traffic and safety matters. The engineers include several from the Ministry of Transport's headquarters and divisional staffs, many from local authorities, a few representatives of consulting engineers, and a small sprinkling of engineers and police officials from overseas territories.

During the last two or three years several lecturers from universities or technical colleges have attended a course to enable them to become better informed, and thus to expand the extent to which highway engineering, including traffic engineering, can be dealt with in their curricula. One or two universities, indeed, are known to be planning to make highway engineering one of the optional final year subjects for a civil engineering degree, which must be regarded as a welcome development. Two or three technical colleges have started evening courses in traffic engineering. These should fulfil the needs of a number of members of highway authority staffs in the surrounding areas.

The material presented at the most recent courses can still be grouped under the subjects enumerated above in connection with the first course, but it is now wider in scope and based on much more extensive and more recent information. The considerable variety of equipment now available for measuring traffic behaviour is described and demonstrated, whilst traffic characteristics are dealt with under the separate headings of flows and speeds (including censuses), capacity (of roads and intersections), urban traffic, (including parking), and traffic studies for road planning (including origin and destination surveys). The control of traffic is dealt with under traffic signals (theory and experiment, optimum settings for minimum delay), physical regulation, including segregation, restriction of movements, speedlimits, and traffic signs (siting, lettering and shape). Road layout and its effects on accident rates and traffic characteristics is considered separately in regard to cross-section and alignment and the design of junctions. The characteristics of road users are dealt with under their main categories: drivers and pedestrians; whilst the results of statistical study of accident factors are presented and shown to bring out many important points. The other subjects are street lighting (general principles and influence on accident rates); skidding (road surface factors, skidding resistance requirements and detection of slippery sites); vehicle characteristics (braking, visibility, design for safety, vehicle lights, equipment for inspection and testing); and economics (case for improvements, economic returns, assessment of priorities). The necessity for careful interpretation of results is shown, and the use of simple statistical tests and methods described; these procedures are something every course member needs to know and can use in the course of his own work.

Group Discussion

Although the earliest courses gave some time for questions and discussion, it soon became clear that members desired more opportunities for the discussion of current problems among themselves. The scheme now operated allows the members to divide into several groups, each of which has three or four periods for the consideration of a problem or topic; a short report is subsequently made to the course members as a whole, and general discussion ensues. These discussions may reveal a general feeling or trend of opinion on current problems, practices or procedures, and, in any case, are stimulating also to the Laboratory staff, and help them to keep aware of current opinion and to appreciate better the factors which affect the problems on which they are working. To this extent, therefore, the Laboratory obtains useful aid from the courses, though their organization necessarily involves a considerable diversion of effort from the normal course of research work.

Of necessity, only a small proportion of the members of the staffs of the several hundred existing highway and police authorities can be accommodated on a course in a given year. Fortunately the demand, though greater than the available capacity in recent years, has not so far been unmanageable. Regular representation is unnecessary, since the material presented does not change very rapidly from year to year, and the proportion of new results and significant new conclusions is bound to be modest. Such new material inevitably appears in print as soon as is practicable. The great majority of engineers and others concerned, including those who have attended a course, must necessarily keep abreast of current results and developments by means of the publications of various kinds, as referred to earlier. A copy of the current list can always be obtained from the Laboratory. Typical examples of Technical Papers are No. 39, 'Traffic Signal Settings', (1958); No. 46, 'The London-Birmingham Motorway: Traffic and Economics', (1960); and No. 48 'The Assessment of Priority for Road Improvements', (1960). Typical examples of Road Notes are No. 23, 'Vehicle Headlamp Testing' (1958) and No. 27 'Instructions for using the Portable Skid-Resistance Tester' (1960).

A 118-page comprehensive list of all publications, papers and articles in which the Laboratory has been concerned, entitled 'Index of Publications of the Road Research Laboratory', covering the period January, 1933 to December, 1958, can be obtained free of charge on application to the Director of Road Research at the Road Research Laboratory, Harmondsworth, West Drayton, Middlesex. Supplements covering publications in succeeding years are being prepared.

1961 Courses

Three courses will be held during 1961 at the Road Research Laboratory's Traffic and Safety Division, Langley Hall, near Slough, Bucks. They will include the most recent results of research and thought on matters relevant to traffic engineering and road safety; opportunities for discussion will be afforded. The courses are designed for senior officials, or those particularly concerned with matters related to traffic engineering and/or road safety.

The dates will be as follows:

Course ST. 16 February 21-March 1.
Course ST. 17 March 7-15.
Course ST. 18 March 21-29.

The fee for either course will be twelve guineas payable in advance. There is no living accommodation at the Laboratory, but a list of hotels in neighbouring localities will be sent to all accepted applicants, and to enquirers on request. Forms of application can be obtained from the Director, Road Research Laboratory, Harmondsworth, West Drayton, Middlesex. Applications should be received by January 20, 1961. (Applications dependent on approval by Committees will be accepted.)

Acknowledgment

The publications referred to above and the courses given at the Laboratory form part of the programme of work carried out under the Road Research Board of the Department of Scientific and Industrial Research. This account is published by permission of the Director of Road Research.

Changes in I.C.E. Examinations

As from October 1962, Traffic Engineering is to be included in Part II of the Institution of Civil Engineers' examination. Other new subjects introduced for the first time are Town and Country Planning, Water Supplies, and Sewerage and Sewage Treatment. For each of the new subjects the syllabus has yet to be approved and will be announced in due course.

INSTRUMENTS FOR TRAFFIC ENGINEERS

The fifth article in this series—ACCELERATION, DECELERATION & FUEL CONSUMPTION is unavoidably held over until next month

Symposium on

URBAN SURVIVAL AND TRAFFIC

Newcastle upon Tyne, April 10 to 14, 1961

IT has long been realized that the problems of traffic congestion, which so plague the cities of this country, cannot be solved unless the three inter-related professions of town planning, civil engineering and architecture work together. *Ad hoc* solutions of local symptoms of traffic congestion are not effective. Such symptoms may well be caused by social factors which are not obvious, and which need professional and technical experience to resolve.

In view of the inter-relation of the three professions, the Professors of Civil Engineering (W. Fisher Cassie), Town and Country Planning (J. S. Allen) and Architecture (J. H. Napper) in the University of Durham have planned an international Symposium to bring together views on urban survival which is so much threatened by the increase in traffic flows. The Roads Campaign Council is collaborating with the University of Durham in this venture. The papers to be presented are technical and it is hoped that those concerned with architecture, planning and highways in the cities of this country will take the opportunity to meet each other and the speakers in this residential conference.

The Symposium will be held in King's College, Newcastle upon Tyne, which is one of the constituent colleges of the University of Durham. The Rees Jeffreys Reader in Highway and Traffic Engineering (Dr. T. E. H. Williams) is in charge of the detailed planning of the proceedings. The members of the Symposium will be provided with single rooms in one of the large halls of residence of the University. There will be no difficulty in accommodating up to 300 people.

Since the views of the distinguished contributors of the Symposium will be of continuing value, the proceedings will be printed and supplied to the members. The majority of the contributors intend to be present in person to present their papers, a full list of which is given on page 546.

Study Tour

In addition to attending lectures and study groups, the members will visit Durham City to view road and redevelopment work, and the use of television for traffic control.

Detailed Arrangements

A brochure giving details of the conference will shortly be available and will be issued widely. Further copies of the brochure can be obtained from: *Dr. T. E. H. Williams, Department of Civil Engineering, King's College, Newcastle upon Tyne, 2.* The cost of the Symposium will be £9 exclusive of residential accommodation and meals, but including the printed proceedings, the study tour, and the official dinner. It is hoped that Chief Officers of Local Authorities will find it convenient to attend and a letter received from the Ministry of Housing indicates that attendance at the Symposium may well be considered as an approved duty under the Local Government Act of 1948.

The Symposium will open on Monday, April 10, at 3 p.m. and will close before lunch on Friday, April 14. Mornings and afternoons will be devoted to lectures and study groups. Activities in the evenings will include a public lecture, technical films and an official dinner.

Presidential Messages

The importance of this conference has been recognized by the Institutions chiefly concerned, and the following messages have been received.

Sir William Holford, P.P.T.P.I., *President of the Royal Institute of British Architects.*

'The Symposium at King's College in April 1961 is clear in its scope and timely in its purpose. This is to exchange practical ideas, against a background of theory, on the most urgent problem facing our towns, namely the rationalization of motor traffic. The organization of the Symposium is in the hands of three professors whose subjects form a triple approach to the main problem—Town Planning, Civil Engineering and Architecture. Acting as a team, they are bringing together specialists in a number of related subjects and from different countries, including West Germany and the U.S.A. The four days of lectures and discussions which will result are likely to make a serious contribution to current thought. If the Symposium attracts the delegates it deserves, it should also have its effect on current practice. I hope it will have the interest and support of those architects who are most concerned with urban redevelopment.'

R. Nicholas, C.B.E., B.Sc., *President of the Town Planning Institute.*

'As President of the Town Planning Institute it gives me the greatest pleasure to wish your Symposium every success. May your deliberations not only emphasize the vast changes in urban life which are before us but also forecast as far as possible the nature of these changes and the solutions which must be adopted in order to accommodate them.'

Concluded on page 546

LETTER *to the* EDITOR

From R. N. Hare, Balliol College, Oxford.

I HAVE been reading with great pleasure Mr. Waldram's article 'Visibility Studies' in your November issue. He describes a type of research that is of fundamental importance in many other fields than that of street lighting which is his primary interest.

An obvious example is the question of hand signals versus mechanical signals (flashers). Both Mr. Waldram's results and common experience indicate that drivers habitually concentrate their eyes and attention on following a safe track with their vehicles. Peripheral vision and background attention, therefore, have to suffice for observing all events outside this main field of attention. It follows that the signals of other drivers will normally have to be observed first by peripheral vision, and only then fixated and attended to. If they are not noticed by peripheral vision, they will not be noticed at all.

Now many hand signals (perhaps the majority are made only for a moment, with hands camouflaged by gloves, or half-hidden by projecting cabs; they are, too, easily confused in peripheral vision with other projections such as side-mirrors. They are therefore likely to be missed unless the driver is fixating the offside front window of all other vehicles simultaneously; and this is clearly impossible, even by day. This explains the large number of court cases in which one driver swears that he gave a signal, and the other that he did not see it.

It should be asked, therefore, whether the law ought not to be amended to make the fitting and use of mechanical signals compulsory, and whether some drivers are right to pride themselves (with backing from some 'authoritative' manuals) on giving hand instead of mechanical signals. More research on this subject would be a most valuable sequel to the Road Research Laboratory's recent work on the relative merits of flashing and semaphore signals.

SAMPLING OF TRAFFIC

A discussion on the Sampling of Traffic was opened by F. Garwood, M.A., Ph.D., F.S.S., Head of Statistics and Planning Section, Road Research Laboratory, at a meeting of the Institution of Civil Engineers Study Group on Traffic Engineering, on October 16. His prepared paper which was chiefly concerned with points of a semi-theoretical nature connected with the estimation of traffic flows (numbers of vehicles passing a point per unit time) is reproduced below.

Where particular attention has to be given to larger vehicles, this can be done by giving them a greater weight, and by using the concept of passenger car units (P.C.U.'s). It should be noted that the integral (that is, in the sense of the integral calculus) of the flow, taken over the linear road system, is equal to the total vehicle mileage travelled over the road system in unit time. 'Average flow' over the road system is then equal to the vehicle mileage divided by the total length. My remarks are concerned more with traffic at one particular point, so that the sampling problem concerns that of sampling in time, although if a length of the same road is being considered, sampling along its length may also be relevant.

One important use to which the knowledge of the flow of traffic should be put is that of deciding whether or not the flow is greater or less than the capacity of the road. In the Ministry of Transport Circular No. 727 on the Design of Roads in Rural Areas, (which it is understood is under review), it is requested that future traffic be estimated as 75 per cent in excess of that counted in a 16 hour, 7-day week in August 1954, and the following standards are laid down:

	Critical p.c.u. per day
2-lane carriageways 3-lane carriageways	4,500
Dual 2-lane carriageways	9,000
Dual 3-lane carriageways	25,000

Evidently for the implementation of this circular, the traffic counts need not have been very accurate, in the sense that if errors had been made in the counts, they would in most cases have to be fairly considerable before a road would be put into the wrong category.

This raises the questions, however, as to whether there are other purposes for which more accurate counts should be taken, and whether counts taken at other times of the year are more satisfactory. An answer to the first question is supplied by the need to calculate the accident rate per vehicle mile of a particular road. Another application is the calculation of the economic return from a new road, or from an improvement to an existing road in conjunction with speed studies.

Capacity

It is relevant to make some remarks here about capacity. There are several ways of approaching the concept, all interlinked and they vary in the way they are based on assumptions. These are as follows:

(i) Theoretical capacities, based on an assumed 'safe headway'/speed relation and calculating the maximum value of flow from this (i.e. the flow for the optimum speed).

(ii) Practical capacity based on arbitrary criteria of what constitutes restriction of traffic movement (Highway Capacity Manual).

(iii) Flow based on observed speed/flow relations and an assumed desired speed (which is a special case of (ii)).

(iv) Economic capacity, based on observed or assumed speed/flow relation and cost of improvement and value of time.

The last approach was suggested by Schuhl and independently by Charlesworth and applications of it are described by Charlesworth, Reynolds and Wardrop. In order to express this mathematically, it can be assumed that the cost c(q,w) per vehicle mile of using a road of width w varies linearly with the flow q according to the formula

$$c(q,w) = c + q\,b\,(w)$$

The constant c is the cost of using a mile of road on which there is no other traffic, and is assumed to be the same at all widths. The quantity b (w) measures the rate at which the cost per vehicle rises as the traffic increases, and it will be smaller the wider the road. We have in mind, in fact, the next largest standard width w*l*, and have to consider whether the economic benefit to the road users of the time saved would repay the cost of widening from w to w*l*, which can be written W (w,w*l*) per year. If it does not, then the actual flow is said to be below economic capacity. In this case the flow would need to be larger than the actual in order to justify widening. In fact, assuming that the time pattern of traffic remains the same throughout the year, it is possible to calculate what the total annual flow would need to be in order to justify the expense of widening. It can be shown that this is given by:

$$\text{Economic capacity} = \sqrt{\frac{1}{1+u^2}}\ \sqrt{\frac{W\,(w,wl)}{b\,(w) - b\,(wl)}} \quad \ldots (1)$$

where u = coefficient of variation of the distribution of traffic flow over the year (e.g. the c. of v. of hourly flows).

Alternatively, the formula is

$$\text{E.C.} = \sqrt{\frac{\overline{q}^2}{\overline{q^2}}}\ \sqrt{\frac{W\,(w,wl)}{b\,(w) - b\,(wl)}} \quad \ldots (2)$$

where $\overline{q}$ = mean flow
and $\overline{q^2}$ = mean square flow.

This formula brings out the facts that economic capacity is higher when

(i) cost W of widening increases;

(ii) effect of congestion in widened condition is higher (large b (w*l*));

(iii) u is small, i.e. when traffic is more evenly spread over the year.

Another aspect of the latter is that increased capacity can be achieved by the 'staggering of hours', which is equivalent to reducing u.

It should be emphasized that this approach assumes that the pattern of traffic distribution will be the same in future as it is now, and that there is a linear cost/flow relationship. In particular, it makes no allowance for complete stoppages of traffic and is thus perhaps more appropriate to rural than urban conditions. The theory can of course be extended to other variables than width. Another feature is that the time saved may have a different value at different times of the day.

The numerical values of the economic capacity turn out to be somewhat greater than those indicated in the M.O.T. circular.

In applying this concept we evidently need information about the annual flow on a road and its distribution. Some of the studies on these aspects will be described in the case of the 50 point census.

50 Point Census

In this census daily records of traffic are obtained at 50 points distributed over the classified road system. The system was so designed as to give as accurate a value as possible, subject to the limitation of there being this number of points, of the trend in vehicle mileage of the classified road system (Trunk, Classes I, II and III). More particularly it was designed so as to minimize the sampling error in the ratio of the annual vehicle mileage to that in the base year (1956). The

(*Concluded on page* 548)

Symposium *concluded from page 544*

Sir Herbert J. Manzoni, C.B.E., *President of the Institution of Civil Engineers.*

'Very few people in this country appear to appreciate the serious effects which can arise from traffic strangulation, but when the density of vehicles approaches that already experienced in other countries, particularly the United States of America, the problem of urban survival becomes a very real one, and instances are known of serious depreciation of town centres arising solely from this cause. It is necessary to do everything possible to impress the public with these dangers before they occur, because only informed public opinion can have adequate repercussions upon those who have the remedy in their hands, and for this reason I welcome all efforts such as this Symposium, organized by King's College of the University of Durham, which should be particularly valuable because of the carefully chosen list of speakers who will bring their experience from countries in some of which the disease is much more advanced than it is here. The Institution of Civil Engineers is doing a great deal to awaken this public consciousness and to ensure discussion towards the necessary solutions, and, as President, I hope that your meetings will be fruitful of an increased awareness of the dangers, and some greater understanding of their solutions'.

James Drake, B.Sc., M.I.C.E., M.I.Mun.E., F.I.H.E., *Past President of the Institution of Highway Engineers.*

'When President of the Institution of Highway Engineers, and Surveyor to an urbanized county, it was with pleasure that I welcomed the decision to hold this Symposium on urban traffic problems. The pattern of our highway needs, outside the big towns is becoming clear, and the lessons from the new roads already operating are being put to use. The value of these routes is being clearly demonstrated, whilst the attraction to motorists is clear. The techniques of this type of work are now becoming established and the only curb on the implementation of a national programme for such schemes is that of finance. The solution of the urban problem is, however, more obscure. If progress is to be made it is necessary that we should clarify the ends to be achieved and the means of obtaining these ends. This is required both to ensure that the measures which are adopted shall secure the improvement hoped for and also to provide the necessary assurance that the money spent on such work will be used to the best advantage. The opportunity for pooling knowledge and discussion, such as will be provided at Newcastle, offers possibilities of a real contribution towards progress in this field.'

CONTRIBUTORS

GREAT BRITAIN

C. D. Buchanan
Comprehensive Redevelopment—the Opportunity for Traffic.

J. T. Duff
Traffic Design in Urban Areas.
(Mr. Buchanan and Mr. Duff, although from the Ministry of Transport, will be presenting personal, and not official, opinions.)

D. L. Munby (Nuffield College, Oxford).
The Economics of City Traffic.

I. Nairn (Architectural Review, London).
The Size of Pedestrian Precincts.

W. Burns (City Planning Officer, Newcastle upon Tyne).
From Town Plan to Traffic Plan.

U.S.A.

Prof. D. S. Berry (Northwestern University, Illinois).
The Team Approach to Urban Transportation Planning.

Prof. D. K. Blythe (University of Kentucky).
Highway Planning as it affects Metropolitan Areas.
(Prof. Blythe will also deliver the public lecture.)

Dr. J. D. Carroll (Director, Chicago Area Transportation Study).
Adapting Urban Environments to Travel Technology, or the Reverse.

Profs. H. E. Davis & N. Kennedy (Institute of Transportation, University of California).
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H. T. Fisher (Architect, Chicago).
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Prof. Scott Greer (Northwestern University, Illinois).
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A. M. Voorhees (Automotive Safety Foundation, Washington).
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THE COMMONWEALTH

J. Mathieson (Country Roads Board, Victoria, Australia).
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Dr. S. S. Morris (City Engineer, Capetown).
Freeways, Parking & Urban Evolution.

EUROPE

M. L. Romero (Traffic Planning Department, Madrid).
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Prof. J. Schlums (Technical University, Hanover).
Traffic Engineering as an Aid to Modern Town Planning.

ROYAL PRESIDENT

H.R.H. Prince Philip, Duke of Edinburgh, was installed as President of the Institution of Highway Engineers on December 15, in the presence of the principal guest, the Right Honourable Ernest Marples, M.P., Minister of Transport. In his remarks, Prince Philip referred to the necessity for more progress to be made in the technique of traffic engineering, and said that at the moment we could only try to catch up with the traffic situation which had developed in recent years and be thankful for the energy with which highway problems had been tackled. But the future was far from rosy, the task was difficult, with the ever increasing numbers of vehicles on the roads, the constant growth of our towns and cities, and the tendency for vast numbers of people to go to the same places at the same time. He did not envy the Minister his job, but he and his Ministry could rely on the unstinted support of the Institution in everything they were trying to do to improve transport conditions in this country. There was no single solution to our roads and traffic problems; there were so many conflicting requirements and only general and rapid improvements on the transport front would meet them—even better and cheaper methods of construction of roads, overpasses and under passes, more convenient loading and unloading arrangements, more progress in the technique of traffic engineering, greater speed and deliberate exploitation of the development of alternative routes across country and in and out of cities. Above all, we needed an enlightened and progressive outlook in all people concerned with transport problems, who could conceive and try out new ideas.

Bursary in Traffic Engineering

The Federation of Manufacturers of Construction Equipment is offering a bursary in the Graduate School in Highway and Traffic Engineering at Birmingham University, with a value of £550 per annum, open to engineers employed by a municipal authority, by a national department of transport or by a public works department in Australia, India, Pakistan and the Federation of Malaya. Its purpose is to encourage overseas engineers to take advantage of the facilities available in the United Kingdom for advanced training courses in the field of highway engineering and traffic studies.

The duration of the bursary course will not exceed ten months. The university course requires nine full months' attendance at the university and a further three months in spare time preparation away from the university of critical reports on the laboratory work carried out during the opening period. Attendance at the university is required from early October until the commencement of the following July.

Applicants must hold a degree in engineering of a recognized university faculty; be employed by a municipal authority, by a national department of transport or by a public works department; be able to speak and write English well; and, undertake to return and follow their profession in their own country for a minimum period of two years. Applications must be received by the Federation at 121, Queen Victoria Street, London, E.C.4., by May 6, 1961.

Automatic Parking

NEUER MARKT VIENNA

by Architect Dipl.Ing. Dr. techn. Karl Schwanzer

Fig. 1. The Wertheim-Autoparker Garage, Vienna, with its four entrances, showing car on left approaching entrance and on right another vehicle being drawn in to the car elevator.

URBAN conditions, particularly in the centres of old towns, do not permit any enlargements of street space for standing traffic. One is, therefore, more and more obliged to house parked vehicles on different levels, that is in multi-storey garages of various systems and constructions, above or below the ground. Earlier than in other countries, this was recognized in the U.S.A. where the traffic density posed this problem more than 30 years ago. Thus, the so-called parking 'houses' were first created in large towns there. The first of these buildings was erected in Boston in 1926, and afterwards many variations, both ramp and mechanical parking garages, were developed and today new ideas are still being found for the solution of this problem.

Mechanical systems in America, include Bowser, Minit-Park, Pigeon Hole, Parkomat and Rotapark; in Europe, Autosilo, Autobox, Au-Ro and Wertheim Autoparker. These systems differ in their types of lifting and conveying installations which can be either stationary, immovable or rotary and laterally movable with either fixed, rotary or movable parking surfaces.

The ramp garage and the mechanical multi-storey garage each has its advantages in differing conditions so that the decision for one of the two systems is not a question of taste, but depends on many economic and technical factors, such as traffic situation, size of building site, frequency and, even, the mentality of the users.

On planning the first multi-storey garage in Vienna—Autolift at the Neuer Markt—the inflexible size of the ground at the corner of Marco d' Avianogasse and Tegetthoffstrasse was known beforehand. However excellent the situation appeared to be at first sight, problems for the solution of the ground plan arose, because of the fixed dimensions of the building lot (20.5 x 26.7 m.) Above all, it was clear that the vehicles could enter from the Neuer Markt and leave directly in the direction of the Tegetthoffstrasse. It was, therefore, necessary to find the appropriate mechanical system to permit the most rational use of the ground plan, one which was of robust construction and required only simple service. After a thorough study of all systems, it appeared advisable to use a new development which met the particular requirements of these special conditions, a system suitable for all types of cars—large or small, and of variable gauge and height—and which would permit construction of a comparatively simple building. Thus the Wertheim-Parker was created with standard proved transporting lifts and control devices which were already known as simple and reliable. The installation for the transport of vehicles into and out of the lift was also simplified. The architectural detailed planning provided four entrances on the ground floor with a waiting forecourt at the side of the Neuer Markt, one lift-shaft behind it and, annexed thereto, the exit hall. Twelve floors were erected above this ground floor and three additional floors underground permitting about 300 cars to be housed. On every floor there are four boxes each for two and four cars respectively. Four lifts, with a rated capacity load of 2,000 kg. each and a speed of 0.9 m./sec., bring the cars to the boxes. Each lift has an attendant who travels with the lift platform. The introduction of the vehicles onto the lift platform, as well as transporting them to the various parking places in the building, is by a mechanical installation, the Wertheim Autoparker, which manoeuvres the cars into place automatically.

The driver leaves his car in the entrance hall and obtains a ticket, the motor is stopped, the brakes released, the lift door opens automatically, and the barrier, which acts as a stop for the front wheels, is lowered. Then a 'tongue' comes out of the lift and is pushed under the car. From this tongue two pairs of rollers are swivelled out, which embrace the wheels. By withdrawal of the catch tongue the vehicle rolls, without being lifted, into the lift car and the shaft doors close. During the journey to the respective floor it is possible to shift laterally the car within the lift so that the vehicle can be pushed again by the catcher automatically to the left or right in the box. The catch carriage rolls on rubber tyres freely on the even floor. This is perhaps the main advantage over other systems which must have recesses in the floors for guiding the conveying device. All conveying operations can be controlled automatically from the same place so that the lift attendant does not have to step into the parking boxes.

The procedure for getting the vehicle back is in the reverse sequence, except that the vehicles leave the ground floor on the other side of the lifts, where also

automatic shaft doors close the lift shaft. Travel time, and the parking operations, are so short that the driver need not wait more than one and a half to two minutes for his car, which is certainly no longer than it takes to get out of a car park. Since there are four lifts available, it is possible to despatch one car every half minute during rush hours.

The hoisting machine is housed in the loft, the other technical installations (electrical, heating and ventilating installation) are located in the basement. On the ground floor there is a service station for washing and greasing the parked vehicles. For the supply of the washing water a separate utility water well has been provided. The necessary rooms for personnel, lavatories and so forth, have also been conveniently planned. There is also a small reception room for waiting passengers.

The building is constructed of reinforced concrete and rests on a foundation of the same material 80 cm. thick. The height of the parking boxes is 1.90 m., the other rooms are 3 m. and 3.80 m. high respectively. In spite of the high loads, such as the equipment of the service station, the lift installation and the parked cars, the structure has slender walls (about 15 cm. thick) and the ceilings, too, are thin, being about 12 cm. thick.

The heating is of the Crittal type and the respective pipes are concreted into the ceiling. This heating provides a temperature of 5° Celsius in the boxes, the boiler is calculated for 390,000 kcal./hr. The oil tank room for fuel stockpiling is in the third basement floor and can be reached by a boiler-house staircase. The mechanical ventilation leads 2,500 m^3./hr. of air into the boxes and gives 2,000 m^3./hr of exhaust air. In the ground floor at the exit there are three filling stations, the respective fuel tanks are located in the vestibule.

Fig. 2. Parking of a vehicle by the mechanical catcher device.

It should also be mentioned that the municipal building authorities contributed much to the realization of this building which is new to Vienna, and permitted new departures, in particular in the interpretation of the legal provisions and in the solution of safety devices newly applied.

The location of this garage leads to the expectation of high profitability, since the garage is used by permanent parkers as well as by parkers by day, by night and by the hour. Nevertheless, a garage in the centre of a town can be profitable only if additional enterprises —such as service station, snackbar, etc. —are incorporated in order to bring in additional revenue, and to enable profits to be adequate for the amortization of the real ground value and of building cost.

For such a multi-storey garage, the cost per parking bay is about 30,000 Austrian schillings, but with heating system and other installations, such as a service station, the cost is naturally higher.

Sampling of Traffic—*continued from page 545.*

results are published monthly, but there are some other by-products relevant to this discussion.

Estimation of Mean Annual Flow

If we knew that the pattern of traffic at every point was the same, then we could estimate total flow at any point by taking a sample count during any hour and multiply by an appropriate constant estimated from counts taken over the whole year at a sufficient number of sample points to eliminate chance errors. In practice, however, we know that the patterns are different.

The 50 points were chosen so as to give a fairly uniform geographical distribution, and about two-thirds of them were in rural areas. This enables us to see whether the time patterns are affected by these factors. The results which have been observed so far are as follows:

Rural traffic shows greater seasonal variation than urban and week-end traffic shows greater seasonal variation than week-day. Because the rural peak (August) is higher than the urban peak, this means that of two roads with the same August traffic one in an urban and one in a rural area, the urban point will tend to have high traffic flows for a longer part of the year.

It is useful to try to express the accuracy of a flow predicted from a short count, and the theory of the method is indicated here.

Suppose p is the proportion of a week's traffic which passes in a particular hour. We can regard p as varying from point to point within the particular group of points we are concerned with. Let $\bar{p}$ be the mean of this distribution, s its standard deviation, and coefficient of variation $v = s/\bar{p}$. If a point is chosen at random from the group and the traffic t in it is counted, then we estimate the traffic in the week to be

$$T = t/\bar{p}$$

This in general will be different from the unknown traffic in the week X so that there is an unknown error

$$T - X = t/\bar{p} - X$$

which can be expressed as a proportionate error

$$x = \frac{T - X}{X} = p/\bar{p} - 1$$

Hence the variance (square of standard deviation) of the proportionate error is

$$s^2(x) = s^2/\bar{p}^2 = v^2$$

and $s(x) = v$.

We can say that there is a 95 per cent chance that

$$|x| < 2v$$

and this implies that there is a 95 per cent chance that

$$\frac{T}{1 + 2v} < X < \frac{T}{1 - 2v}$$

In other words we can say within what limits the true value is likely to be on either side of our estimated T.

In practice we require to make v as small as possible, and we aim at choosing a particular time of day, week or year at which for a given length of count, v is a minimum.

In practice the best procedure appears at the moment to be that of predicting a day's traffic from an hour's, the week's (or month's) from the day's, and then the year's from the week or month. It has been indicated previously that April and September appear to be the optimum months for the last operation, so that what is required are the days or a week in these months and the hours within the days at which the v's for the other operations are minimized. Unfortunately these are not available but some data have been analysed for July by Mr. Tanner and Mr. Sehgal at the Road Research Laboratory. These show that for the hour to day prediction the co-efficient of variation is fairly uniform at about 15-20 per cent between 9 a.m. and 7 p.m., i.e. there is no great advantage from the point of view of accuracy, of taking one hour rather than any other during this period. Had a Saturday or Sunday been chosen, the variation would be a little greater. The accuracy tends to be lower at the points with less flow.

WORK of a TRAFFIC ENGINEER

by E. Ogden, B.Sc., A.M.I.C.E., M.I.H.E.

Under the auspices of the Institution of Highway Engineers, Lancashire's Traffic Engineer spoke to the Public Works and Municipal Services Congress on the Development of Traffic Engineering in a County on November 14, 1960. Extracts from his paper are given below.

'THE keynote of papers concerned with traffic engineering presented over the last decade has been the desire to show that this subject should be accepted as a fundamental branch of highway engineering. There is now no doubt that traffic engineering has arrived and is in process of settling in. A full scale Parliamentary Debate and the publication of its own magazine *Traffic Engineering and Control* bear witness to this

'The preparation of the Lancashire Road Plan from 1947 to 1949 was carried out at a time when the allocation of money for roadworks was very small and, consequently, it was possible to divert appreciable staff resources to the study. On its completion, this staff was released to normal duties, but a nucleus was retained to continue working on traffic and road safety problems. From this has developed the Traffic Engineering Section of the County Surveyor's Department. Demands for the services of this section are continuously growing, and the following may give some idea of various aspects of the work carried out.

'One of the most frequent tasks undertaken by the Lancashire county traffic engineers is the preparation of traffic appreciations for road projects of widely varying scope and magnitude. These projects have included national motorways, and estimates have been given for traffic volumes along the road, for various directions at the intersections occurring on the road and of the associated reliefs on existing roads. Other investigations involve reports on alternative lines for by-passes, particularly with regard to the differences in traffic likely to be picked up on such by-passes and the effect of these differences on economic value, capacity and safety. On a smaller scale the need for settling improvement lines as they affect development proposals on existing roads requires the design of intersections including traffic forecasts at places which are affected by traffic growth and redistributions.

'In short, the traffic engineer is expected to be in a position at any time to forecast conditions under a large variety of circumstances for any roads in the area for which he is responsible. Plans and detailed designs are of course directly affected.

'It is out of the question to have available up to date origin and destination information for all the traffic distribution problems which the traffic engineer is required to solve so that improvisation based upon available data, knowledge of traffic behaviour generally and of personal acquaintance with the routes is necessary. It should be appreciated that even when full O. & D. information is available estimates of traffic likely to take advantage of proposed new facilities still have to be made and allowance included for 'generated' traffic. In other words the processes involved are not merely arithmetical but as in other branches of engineering require the application of judgment and experience.

'The tools available for carrying out traffic analysis are:

Information regarding volumes and capacities

(1) Volumetric counts, by types of vehicle and hours for Class A and B roads, in accordance with Ministry of Transport standards.

(2) Estimates of annual variation necessary to keep the values at (1) up to date.

(3) Miscellaneous daily volumetric counts from censuses at intersections, for traffic light investigations or other similar counts.

(4) Pilot counts at strategic points related to the purpose in hand, factorized up to normal 16-hour volumes by application of normal ratios obtained from (1).

(5) The traffic engineer's knowledge of the road. From information at (1) and normal everyday driving along the roads in question it is possible to recognize what various traffic volumes look like. Such observations in fact lead to an ability to estimate volumes on proposed roads.

(6) Miscellaneous running counts obtained from mechanical counters. Even if not situated on roads under investigation, the variation with time can give guidance in correcting other counts such as (3) to design values.

(7) Full scale volumetric counts especially designed for the purpose in hand.

Information regarding Traffic Journeys

(8) The variation between volumes along routes obtained for (1) gives useful information regarding direction of flow—in such cases changes in volume are mainly confined to major intersections. Growth in traffic along a route without major intersections is normally due to vehicles originating in that area.

(9) Knowledge of traffic behaviour resulting from day-to-day driving over the routes in question by trained observers during their routine duties. Where necessary special arrangements for further journeys can be made to brush up knowledge or supplement existing impressions.

(10) Knowledge of traffic behaviour as given by published work, notably for example the varying proportions of through traffic likely to be calling at towns of different total populations.

(11) Pilot censuses on restricted samples, e.g., observation of registration numbers can be used conveniently for localized investigations.

(12) Information from origin and destination censuses previously taken. It will often be found that certain traffic components on which information is required are already available. For this system to be used it is essential that the factual results of any investigation are permanently filed in a manner which can be readily understood. In this connection there is a tendency only to preserve the solution, e.g., the estimated traffic on a route, and it can be very difficult to work back from such information with advantage.

(13) Origin and destination surveys designed for the purpose in hand.

'By way of summarizing this section on traffic analysis, it is recommended

When special circumstances arise at a junction controlled by Type 54, added facilities can be brought into service.

Provision is made for simulation of a continuous demand, and for vehicle extensions on any selected phase. This facility might be required in the event of a failure of a detector, or when road works prevent vehicles from operating a detector . . . *or* Reversion of right-of-way to a selected phase in the absence of traffic requiring any other phase . . . *or* Right-of-way to be given in accordance with the phase cycle and in no circumstances to omit a selected phase.

This junction shown below is served by a 3-phase controller. Two of the phases (A and C) are used for normal traffic while the third phase (B) permits the safe, rapid turn-out of appliances from the fire station. Phase B is operated by remote control from the fire station. On receipt of the 'call', the controller, regardless of waiting demands, transfers the right-of-way to phase B either after the expiry of the minimum green of the running phase, or immediately if the minimum green has expired.

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that all statistical information obtained for roads in any area should be compiled with a view to its permanent availability. The traffic engineer should build up a picture in his mind as to the physical significance of the traffic conditions associated with such figures, and against this background assess the reliability of the results of analysis.'

After dealing with accident analysis, Mr. Ogden turned to traffic engineering aspects of motorways and referred to studies made in connection with M6.

'Preston By-Pass (M6) was opened in December, 1958, and this gave an opportunity to study the effects arising from a major change in the traffic pattern. Before the by-pass was built various investigations of traffic flow and safety had been carried out to assist in the design of the road and junctions, to determine the likely effect on other roads, and also to establish justification for the scheme. One of the earlier investigations compared population with the volumes of traffic entering towns. In the case of Preston the ratio of the total seven-day traffic volume for all trunk and Class I roads crossing the boundaries to population amounts to a value of 7.2 vehicles per head per week based on current traffic. Values for other towns in Lancashire was generally between one-third and a half of this figure: exceptions being Lancaster and Warrington which are also situated on the line of M6. The high proportions of traffic entering a town provide clear indication that much is by-passable.

'Subsequent work included an origin and destination census south of Preston. Whilst this was primarily intended to forecast traffic on the Preston-Wigan section of M6, the comparison of the figures with the traffic using Preston By-Pass was valuable both as a pointer to traffic behaviour and also as a means of determining likely increases in traffic on the by-pass when various links were provided.

'The present traffic on Preston By-Pass is principally that from the South and East to Lancaster, Morecambe, Cumberland and Scotland, the traffic components totalling 6,401. In addition to this must be included traffic likely to use the by-pass which originates north of the screen line. This includes traffic from Blackburn, Chorley and Leyland areas and is assessed at 2,000 vehicles per day giving a total volume of 8,401 vehicles per day. Measured values of traffic on the by-pass in August, 1959, gave an average of 8,700. A similar investigation made in respect of goods vehicles gave values of 2,044 which might have used the by-pass and experience showed the average over the week to be 1,540.'

After dealing with the safety of traffic on motorways and concluding that results so far obtained gave rise to optimism, Mr. Ogden said that since the field of traffic engineering was very wide, he would attempt to demonstrate the nature of the problems in more detail by reference to current work, examples of which were given and were intended to be representative of the kind of work carried out in a traffic engineering section. They included:

Case I
Description Coroner reports fatal accident at bend on moorland road, states other accidents of varying degrees of severity have occurred at same place recently.
Action ... Obtain details of other accidents and views of police.

Case II
Description Police report on experiences at Easter on main North-South route including motorway by-pass terminals where capacity of route decreases sharply. Wide variety of points raised including white lining, junction layout and road widening.
Action ... Ministry of Transport involved. Arrange joint inspection on site with police. Obtain views of other sections of County Surveyor's Department affected by proposals.

Case III
Description Application from Rural District Council for 30 m.p.h. speed limit on Class III roads through village.
Action ... Inspect and refer to the police and Ministry for observations. Not felt to be justified.

Case IV
Description Application for halt sign from delegated authority.
Action ... Routine matter. Consult with police and submit to Ministry for authorization.

Case V
Description Origin and Destination Census for Manchester conurbation.
Action ... Detailed arrangements in hand for census to be carried out by County Divisional Surveyors and local authorities.

Case VI
Description Double white line system to be extended to all roads. (Ministry of Transport Circular No. 764).
Action ... Work out policy and procedure as to how this shall be done.

Case VII
Description Seventeen injury accidents have occurred during a period of four years at an intersection on a four-lane trunk road and outside an adjacent roadhouse.
Action ... Recommend to Ministry that a section of dual carriageway be constructed covering the intersection and roadhouse; preferably without openings through the central reserve at the latter as right turns are the primary cause of the majority of accidents here. If accepted scheme would be developed as a major improvement and be subject to special grant.

Case IX
Description County Council order imposing No Waiting restrictions on 1½ miles of busy Class I road through ribbon type town.
Action ... Order to be advertised and will be confirmed if no objections.

John L. Beckett, City Surveyor, Leicester, will write on Traffic Engineering in a County Borough in the February issue.

In conclusion, Mr. Ogden spoke of the integration of traffic engineering with the County Surveyor's department and of the profession of the traffic engineer.

'The integration of traffic engineering with the organization of the Lancashire County Surveyor's Department was a comparatively painless operation. It was carried out gradually over a number of years and this had led to work, such as the Traffic Engineering Department is best able to handle, gradually migrating in that direction. The scope of possible duties will have become apparent from the information given. It should be appreciated, however, that all the work described is not extra work requiring extra staff but is largely a re-orientation of responsibility. Thus, all work associated with design of minor improvement realignments (i.e., those not involving land acquisition), provision of traffic islands, guard rails, lay-bys, draw-ins, traffic signals, traffic warning signs and white lines could be carried out by a traffic engineering section and the men at present responsible for such work might form the core of the section or be cleared for other duties.

'Although the author feels that traffic engineering has arrived it is not so clear *how* the traffic engineer arrives. In the case of Lancashire, all the traffic engineers have initially been associated with some other branch of the profession. The transfer to traffic engineering has been facilitated because the potential of the County made it possible to offer opportunities of a satisfactory career in this field.

'There are generally, however, two features which must be reconciled. There can be little doubt firstly, that the profession is primarily that for a specialist. Secondly, that traffic engineering decisions are matters of the greatest importance in the work of a highway department particularly in an expanding economy and it is essential, therefore, that decisions based on traffic engineering should be presented to the directing head with full force and lucidity. This cannot occur from a junior level. In other words, the traffic engineer must be a specialist and hold a senior post. Any tendency to create traffic engineering mechanics as opposed to traffic engineers for principal responsibility should be guarded against.

'Specialization normally implies a block in a career and therefore traffic engineering positions must be sufficiently attractive to overcome this disadvantage. It must be appreciated that at present the prospects for a potential traffic engineer are obscure and this must affect recruitment in this field. In these circumstances it is likely that staffs will continue to be formed by transfers from other branches of the profession. The implication of this is that training will normally be confined to experience within the department supplemented by the study of published material and short courses such as are organized by the Road Research Laboratory.'

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AP 122

LIGHTING SECTION

MOTORWAY LIGHTING REQUIREMENTS

J. M. Waldram, B.Sc., A.M.I.E.E., F.Inst.P.

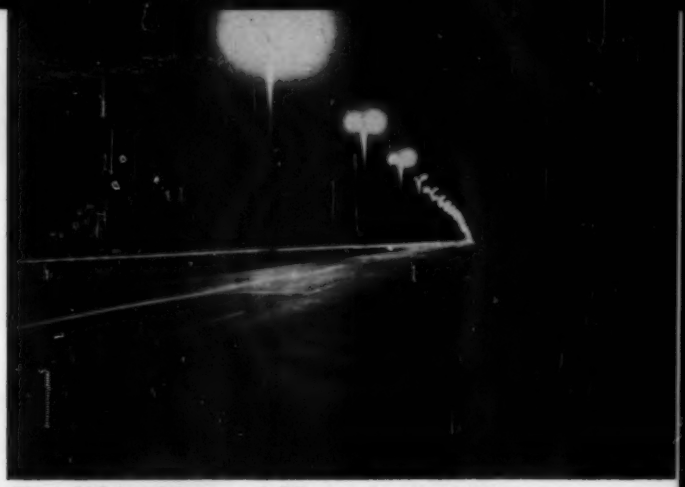

Fig. 1. Lighting of Autoroute de l'Ouest. Photo by the Author.

THE following extracts are taken from a paper on 'Visual Problems of Motorways' given by Mr. Waldram, of the Research Laboratories of the General Electric Company, to the Illuminating Engineering Society on December 13, 1960.

At present on motorways, night driving is by headlights, and one can see very little with them. For a substantial part of the time they have to be used dipped, although as the central headlight screen is extended it may be possible to use driving beams more. The useful range even of the driving beam, in revealing the course of the motorway by the reflector studs of the lane markings, is quite short, perhaps 3-400 ft., and with the dipped beam it is a good deal less. The first consequence is that one drives only by the studs and the lights of other vehicles; the conditions are not unlike those in the blackout, when every light was significant. Even the fixated eye cannot identify objects ahead, though occasional glints may give clues. The run of the road ahead is unknown, unless it is indicated by vehicle lights. This is much more serious than merely a restriction of information on where the driver will have to go, which is not very important on a road in which there will be no hazards of alignment. Other vehicles are seen only by their obligatory lights, and unless those lights can be located on a recognizable picture of the road, they cannot be located; moreover, their closing rate cannot be estimated. The driver does not know what the other vehicles are, where they are or what they are doing. At night he sees the lane lines and vehicles clearly only for a short distance; beyond is a cloud of red lights which it is often quite impossible to interpret. Large vehicles with two sets of rear lights at different levels can be misread and their distance wrongly estimated, especially when the lower set is obscured by mud. The run of the road ahead may be quite different from what one had imagined; consequently, vehicles ahead sometimes seem to make the most incomprehensible movements.

The lane reflector studs of course come rapidly towards the observer; the other lights move about slowly, but their movements cannot be interpreted without the frame of reference of the remainder of the perspective. Closing rates cannot be estimated unless the vehicle is so close ahead that its lights appear to move rapidly relatively to the others, by which time it may be too late to take safe avoiding action. A stopped vehicle on the carriageway would be most unlikely to be correctly interpreted, and an unlighted obstacle would certainly not be seen in time for safe action. Some indication of range is given by the point brilliance of the lights ahead, but their power varies so much that it is an unsafe guide. If one can be sure that two lights seen ahead are those of the same vehicle, its range and closing rate can be estimated from their separation and its rate of change; but vehicles hide one another and one may easily be misled. Glare from headlights on the other carriageway is another difficulty, especially when either of the vehicles concerned is on the fast lane, which brings them closer together. The central headlight screen will greatly reduce this glare, but with some configurations of road involving vertical curves, headlights will inevitably be seen over the top of the screens; usually, however, they will be well off axis and at a fairly long range, so that the glare is reduced.

Closing rates of overtaking vehicles which are seen in the driving mirrors are much more difficult to assess; the field of view is restricted, and there is no frame of reference at all.

Patchy fog is a real menace at night when the only lighting is by headlights. There is no effective way of revealing it until the driver has entered it at speed, when the consequences are far more perilous than by day.

Notwithstanding all these difficulties, driving at night on the motorway, though far more exacting and fatiguing than by day, is safe so long as everyone keeps the rules, and with present traffic the accident rate is quite small. But evidently headlights alone give quite insufficient information; the chances are fairly high of misreading the traffic situation, and of getting into difficulty if anyone does the unexpected.

It is clear that vehicle headlights as used at present are not adequate to give the driver the information which he needs for high speed driving, and that they never could be. The present useful range of headlights, when showing up reflector studs, is of the order of 400 ft.; it would probably be necessary to increase this to at least 1,000 ft. for speeds up to 70 m.p.h. This is needed to give a frame of reference for locating traffic ahead. Without allowing for atmospheric effects, this calls for an increase in headlight intensity of some 40 times, for the intensity required will vary approximately as the fourth power of the range. If the (day) meteorological visibility range is two miles, the intensity required will be increased by a further 2.2 times approximately, without allowing for veiling haze. This gives intensities in the range between one and 10 megacandelas, which, even if they could be realized on the vehicle, would be intolerable if the headlights were encountered as a glare source. Moreover, such headlights would not by themselves clearly reveal the traffic situation ahead, nor would they give adequate warning of fog; indeed, judging by experience with searchlights, it might be difficult to see clearly by such lights over a long range.

Fixed lighting is capable of revealing to a driver on a motorway all the information which is available to him in daylight; if it does this, it does all that lighting is capable of doing. An example is the excellent lighting on the Autoroute du Sud, recently installed near Paris, where drivers drive just as in daylight, without headlights. Good fixed lighting does not limit the distance at which objects can be seen; these are visible up to the topographical range beyond which they are physically hidden. The lanterns give an unusually good indication of the course of the motorway, and provide adequate indication of fog and of its density. By good fixed lighting the driver is shown the perspective of the road, and can, therefore, locate other vehicles and estimate closing rates; he can judge overtaking traffic in his mirror. Unusual conditions,

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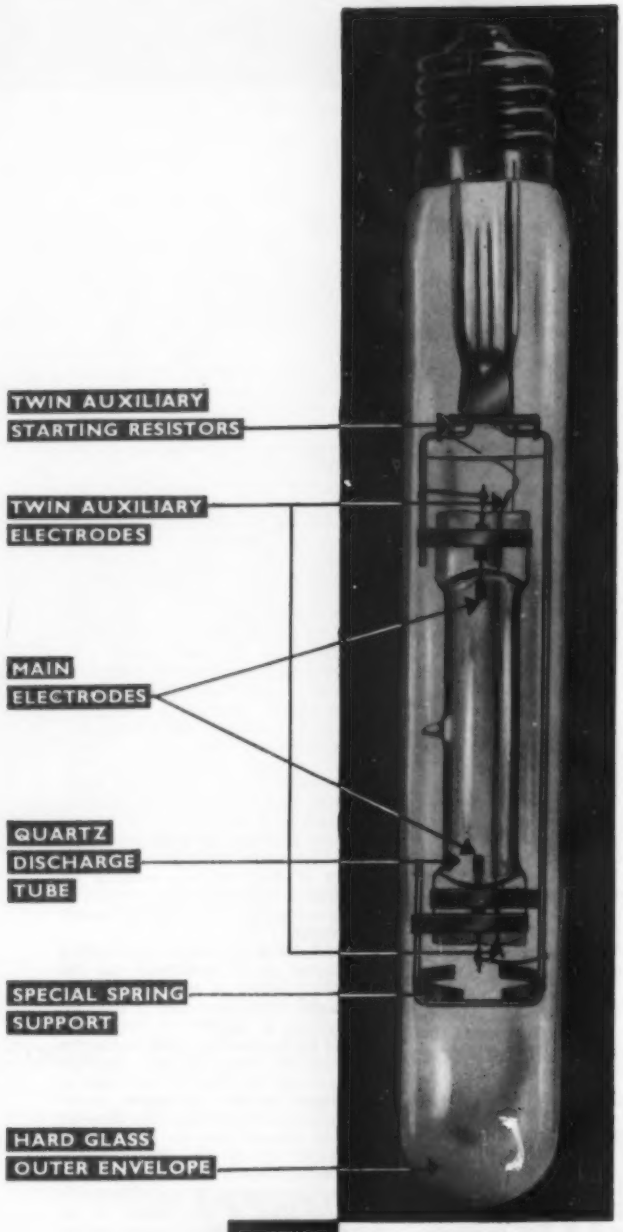

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The new 250 and 400 watt lamps give 25% increase in lumen output and are completely universal in burning position. Magnetic arc deflectors are no longer necessary.

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- *Five Ratings — 80 to 1000 watts.*
- *Quartz discharge tubes for reliability, long life and maximum efficiency.*
- *250 and 400 watt replace former MA/V—give 25% more light.*
- *Twin auxiliary electrode circuits in new lamps.*
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Fig. 2. Appearance of a constellation of lights. Photo M. L. Gaymard, Paris.

accidents or stationary obstructions can be appraised.

There are of course disadvantages, of which the worst is the hazard of columns to a car leaving the carriageway out of control, especially columns on the central reserve. Another is the tendency to form confusing forests of columns and constellations of lights, particularly at complex junctions (Fig. 2), the more so since the installation can usually be seen for a very long distance ahead.

The following requirements are set down partly as the result of the visual experiments and partly from experience of the few installations of motorway lighting which it has been possible to visit. Only requirements which arise from driving conditions are discussed; there are many other economic and engineering requirements.

(1) The first requirement is to show clearly the carriageway ahead, sufficiently well to reveal any vehicles on it so that their position and closing rate can be judged. The luminance should be high enough to reveal any obstacle, or to show what has happened if an accident has occurred.

(2) The rearward view should similarly permit the distance and closing rate of overtaking traffic to be judged in the mirror.

(3) The luminance of the road surface should be as free as possible from obvious patchiness, which is confusing especially when it forms a background to an object of small substance. A smooth variation in luminance across the carriageway is probably less troublesome than a mottled or patchy effect, and it should be achieved on a wet surface as well as on a dry surface. A light-coloured running surface will greatly assist the lighting.

(4) It is unnecessary to provide for good visibility at the margins beyond the running carriageway, though the limits of the carriageway should be very clear.

(5) It is necessary if possible to provide good visibility of vehicles ahead when they are near the crest of a rise, since with the gentle vertical curves on motorways such objects may be deprived of a background of road surface for some distance.

(6) It is very important to avoid discomfort glare, which can be distressing on a long run. There are no light buildings at the sides which would alleviate discomfort glare, and many more lanterns are visible.

(7) It is important to avoid repetitive effects from the lanterns as the car traverses the installation, such as occur with a sharp cutoff. It is similarly important to avoid a repetitive flash on a wet or dusty windscreen.

(8) Columns or supports should not be placed on the central reserve and should be at as great a distance as possible beyond the hard shoulder. They should be so constructed that a vehicle striking them will not suffer avoidable serious damage, and if the column is carried away lighting equipment will not fall into the road.

(9) Constellations of lights are to be avoided, especially at complex junctions, where the siting of lights should be carefully designed to lead vehicles clearly to the available paths, which should be distinguished appropriately; the use of lamps giving light of different colours might be considered.

(10) The lights on the motorway should form neat lines which clearly indicate its course for a long way ahead, and should be such as to give adequate warning of the presence and density of fog.

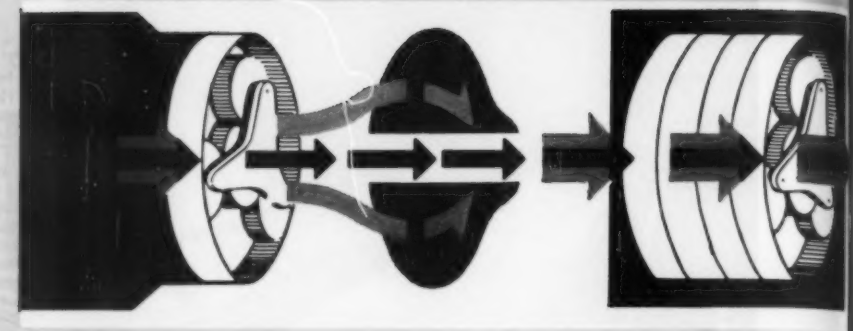
(11) The lighting equipment should be as inconspicuous as possible so that by day the long runs visible do not appear to be cluttered with forests of columns as in Fig. 3.

The value of street lighting from the point of view of safety is to be judged in the end by the reduction of accidents which results from its installation. At present the accident rate on most motorways is low, and this has been given as a reason for not installing fixed lighting. However, on some busy motorways the accident rate has been high, and it was for this reason that lighting was installed on the Autoroute de l'Ouest out of Paris (Fig. 1). As a consequence the night accident rate fell by 27 per cent, and after this experience it was decided in principle to light all future autoroutes. Questions of policy are outside the scope of this paper, but it may be asked whether in some quarters it has come to be regarded as inevitable that there should be some traffic accidents, and there is reluctance to take remedial measures unless their number becomes excessive. If this philosophy exists, it lags behind that applied to travel by rail, sea and air, where we do not wait for disasters before taking all reasonable precautions. Admittedly in these cases there is not usually a call to light the routes throughout their length; nevertheless the aim is to provide so far as possible really safe conditions with plenty in hand, and not to rely on conditions in which, given reasonable luck, one generally arrives whole.

It seems clear that without fixed lighting the visual information given to drivers is not adequate for safety, and that in consequence the accident rate can be expected to rise as traffic density on the motorways increases. Fixed lighting has been shown to be capable of supplying the visual needs of drivers and of making the roads visually as safe and as expeditious at night as by day, and it is felt that a technical case for its installation has been made.

A short report on the discussion that followed Mr. Waldram's paper will be published in the Lighting Section of this Journal next month.

Fig. 3. Impression made by a forest of columns. Photo M. L. Gaymard, Paris.



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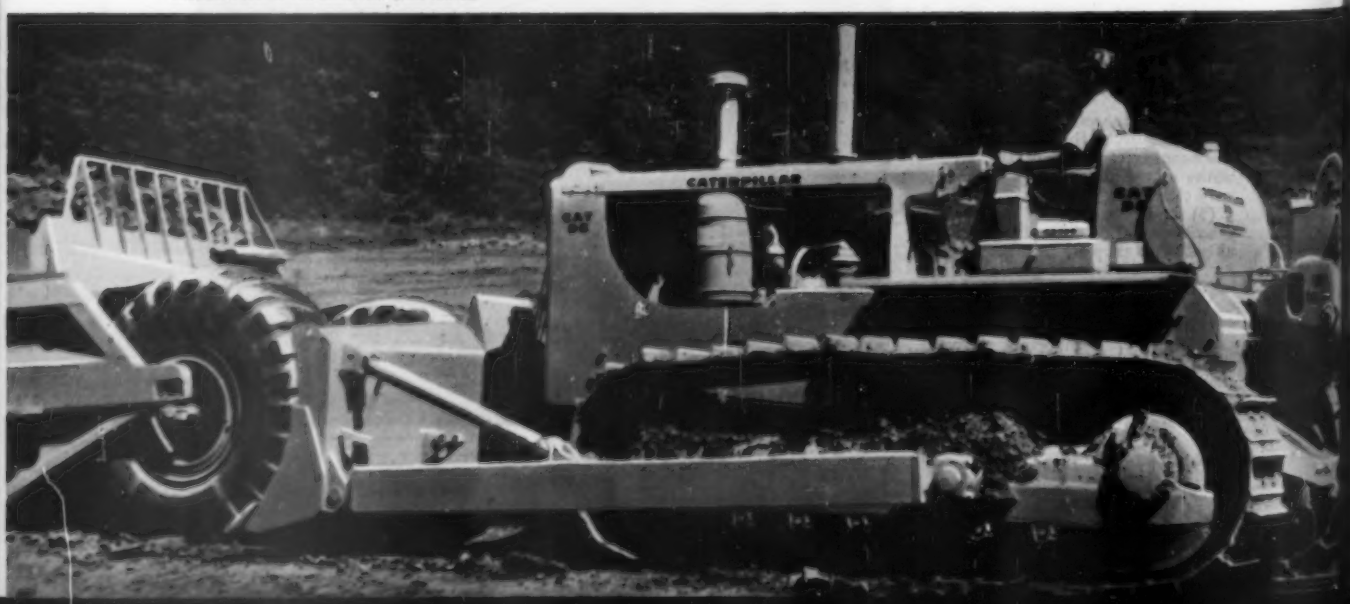

PUBLIC WORKS and MUNICIPAL SERVICES

EXHIBITION REVIEW

Access Equipment Ltd.

On this stand was shown an electric vehicle by Harbilt on which was installed an extendable work platform, the Tallescope. This light, aluminium, telescopic platform is easily removed from the vehicle and with the simple addition of castors becomes a mobile platform with a working height of 26 ft., ready for use inside or outside buildings. The Tallescope extends quickly for reaching heights up to 26 ft. yet telescopes and folds down for rolling through doorways 6 ft. 6 in. high by 2 ft. 6 in. wide. Each leg has 24 in. of adjustment and can be instantly extended or retracted as required to compensate for uneven surfaces. A single lever action locks the castors firmly, preventing rolling or swivelling when in use. It can be dismantled into three component parts for storage and transportation, and assembly, made possible by the patented locking hooks which lock the sections together, can be carried out in one minute by one man.

T.E.C. 135 for further details

Armco Ltd.

This company showed a number of items on their stand of particular interest to traffic engineers.

One of these items is the Flex-beam guard rail, for marking the limits of travel on roads. It is formed of deeply corrugated galvanized steel rail, with strong splice joints of high-tensile steel nuts and bolts. It behaves under impact as a continuous beam, restraining vehicles which get out of control and guilding them in such a way as to lessen the damage and eliminate the danger to other road users.

Armco multi-plate pipes are available in diameter sizes up to 15 ft. One such pipe was recently installed under the site of a new carriageway of the Ross Motorway. This 15 ft. pipe was installed on site on a foundation of selected fillings, backfilled with similar material and, as soon as the top was covered to a depth of 2 ft., heavy earth moving equipment was able to drive over the structure without delay.

Armco multi-plate structures are supplied as curved plates up to 1 U.S.G. (.2758 in.) thick with nuts, bolts and tool kits. The structures can be assembled in the field with only semi-skilled labour and the simplest equipment. The foundation and backfill is any firm granular material placed in layers and well packed. Properly done, this ensures that the structure is able to develop its full strength. Bevelled, skewed or skew-bevelled ends can be made up to match the slope of the enbankment, saving the cost of expensive headwalls.

T.E.C. 136 for further details

The Tallescope.

Atkinson's Agricultural Appliances Ltd.

This company are manufacturers of spreading machinery for laying grit, sand or salt on snow covered roads. Their range is comprehensive and includes trailer, chassis mounted and independently power operated machines with capacities from 2 to 12 tons. The largest of this range is a specially designed model for use on motorways. With this machine, which is mounted on a Douglas chassis, grit can be spread across the full width of a motorway carriageway at speeds of up to 40 m.p.h. Models are also available with a twin body system, which allows salt and grit or sand to be loaded separately and spread either unmixed or combined according to the requirements of immediate conditions.

T.E.C. 137 for further details

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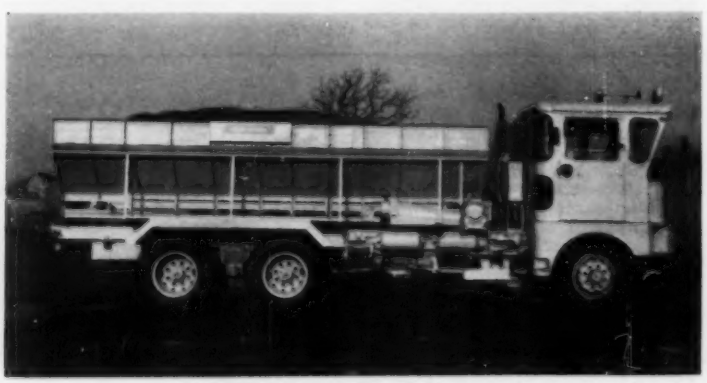
Barber-Greene Olding & Co. Ltd.

Making its first appearance at the Public Works Exhibition, the Model 892 BatchOmatic asphalt plant represents the most modern development in the Barber-Greene line of batching plant. It has a capacity of 2,000 lb. and is the first plant designed from its original conception for fully automatic operation. A multiple weigh hopper permits simultaneous measuring and weighing of four stone sizes plus filler, while the side walls of the hopper are adjustable by hydraulic control, either separately or simultaneously. The binder is measured, weighed and sprayed by a dial-set mechanism incorporating an adjustable suction pipe. Hydraulic valves located directly on the rams are electrically controlled, greatly reducing and simplifying hydraulic pipe fitting and valves. All electric controls are either sequence relays or simple cycle timers and no delicate thermionic mechanisms are used. The plant can be operated by fully automatic, semi-automatic or manual controls. Pre-set mixes are automatically cancelled when a special mix is required, but the control metering and weighing are automatically returned to the standard settings when the special mixing is completed.

T.E.C. 138 for further details



An Atkinson spreader for use on Motorways.

The Wakefield 120 grader.

Construction Machinery Ltd.
Both the graders on this company's stand were established machines, but both have been the subject of recent developments.

Model 120, now having a base weight of 25,040 lb., has had the front end altered to simplify the attachment of bulldozer and snowplough fitments. A T-type drawbar of greater strength has been introduced, which allows increased clearance for scarifier operations, and a new pitch adjustment for moldboard and scarifier. This consists of a racked slot, which enables adjustments to be effected quickly, the bolts being positively retained by the rack. Throughout, servicing has been facilitated by easier access and by improved positioning of such things as oiling points. The power unit of the Wakefield 120 is the Leyland AU600 diesel developing 130 b.h.p. at 1,800 r.p.m. An important feature of this model is the correct weight distribution, to give maximum tractive effort and blade pressure, and a heavy front end for good flotation. The standard tandem drive is by chain, although an all-gear drive can be provided when required. Another feature is the simple but precise hydraulic system, which controls all grading movements and gives boost to the combination steering. Blading movements are smooth, positive and free from 'creep'. The moldboard can be raised to 90° in the vertical plane for high bank sloping, either to left or right of the grader. There is a comprehensive range of optional fitments, including hydraulic shiftable moldboard, scarifier, bulldozer, snowplough, cabs and four-wheel brakes. A 'creeper gear' is also available, giving a greatly increased range of slow speeds for special grading jobs.

The smaller Wakefield Model 603, which is marketed as a maintenance and light construction grader, has also been the subject of various developments, many of them detail modifications. Hydraulic brakes are fitted to two rear wheels (optionally to four rear wheels), in addition to a mechanical parking brake on the transmission. The Wakefield 603 is particularly adapted to the needs of local authorities—county or municipal. It has a 50 h.p. International Harvester diesel engine with tandem drive, and is a lively performer within the range of its capabilities.

T.E.C. 139 for further details

Hydraulic Pumps
Lucas hydraulic pumps and motors are being incorporated into the hydrostatic transmission systems on an ever-widening variety of vehicles and machinery. Two applications which were seen for the first time at Olympia were on a Winget concrete mixer and a converted Land Rover. A hydrostatic transmission is employed to drive the mixing drum of a Winget concrete mixer. It incorporates the Lucas I.P. 1,000 industrial hydraulic pump and allows the driver to control mixing speeds by means of one lever. A Land Rover employing hydrostatic transmission giving one lever control of operating speeds and reversing is used to drive a 'Rolba' snow plough. The application of a Lucas I.P. 125 hydraulic pump in this system was clearly illustrated by means of a working rig on the Rolba stand, which consisted of a set of wheels and rear axle driven by a Lucas pump. This rig was operated through its speed range by means of a single lever. These hydraulic units are produced by Lucas Industrial Equipment Ltd. whose name was recently changed from Joseph Lucas (Hydraulic and Combustion Equipment) Ltd.

T.E.C. 140 for further details

Mackay Industrial Equipment Ltd.
A new 87 horsepower tractor shovel, now being manufactured in Great Britain by Allis-Chalmers, was on show at this stand. One of the many features of this machine is the power reversing tractomatic transmission, with a lever on the steering column to control both forward and reverse movement without stopping the machine to clutch and shift gears. The lever hydraulically engages the two multiple disc, dry type clutches, one for forward travel, and the other for reverse. The BTL.14D has four forward speeds up to 22.3 m.p.h., and four reverse speeds to 29.3 m.p.h. Reverse speeds are approximately 30 per cent faster than the forward speeds in the same gear, permitting a faster loading cycle without shifting to a higher gear to achieve the same effect.

In addition to a single stage 3:1 ratio torque converter, the transmission also has an automatic clutch cut-off, which disengages the clutch when the brakes are applied and places the transmission in neutral, thereby diverting full engine power to the hydraulic system for faster loading and dumping. As a safety factor the clutch cut-off can be disconnected by a lever in the operator's compartment.

Various bucket sizes are available for the BTL.14D ranging from 1 to 3 cu. yd. The standard bucket size is 1½ cu. yd., and a breakout force of up to 18,800 lb. is obtained at the cutting edge. The hydraulic system is fully enclosed and protected. Oil is triple-filtered by full-flow micronic, magnetic and wire mesh filters. Four-wheel drive, four-wheel, power assisted brakes and pin connected planetary axles are standard equipment, and the power is supplied by an A.E.C. AV 312 87 h.p. diesel engine.

T.E.C. 141 for further details

The Merton Engineering Co. Ltd.
The Merton Sherman 'Universal' combines the hydraulic Frontloader 59 and the Sherman Panther power digger. The advantage of the Merton Sherman 'Universal' is the way in which the digger, when not in use, is carried in a folded position, almost within the overall length of the standard Frontloader 59, in a compact unit only 17 ft. long. This arrangement has been largely made possible by the design of the Frontloader 59 itself. This machine, in addition to having semi-automatic hydraulic controls, which take over routine operations and speed the loading cycle, has a front-mounted driver's cab, giving the operator an unobstructed view of the bucket and ground in front. The mounting in this position allows, at the back of the machine, the space

The Allis Chalmers BTL 14D tractor shovel.

which Mertons have now used for the mounting and stowage of the Sherman digger. Because the presence of the digger makes virtually no difference to the dimensions or stability of the shovel it need never be dismounted, even when the loading shovel is required for arduous work in confined spaces. The machine can change functions often and it takes only two and a half minutes to lower or raise the digger and be ready for work in either role. The raising and lowering of the digger is a one-man operation. By means of a remote control lever on the outside of the machine the loader booms are raised; two tie-bars (carried alongside) are inserted between the digger and the main loader rams and the 'travel' locking pins are removed; the loader booms are lowered and the digger pivots down into its working position; the locking pins are replaced in the 'working' position and the digger is ready for work. By reversing the drill the digger can be stowed away equally easily. The Sherman Panther is a robust power digger with hydraulic stabilizers, individually controlled by a lever, allowing the machine to be set up level on sloping or uneven ground and thus giving maximum stability and a vertical trench. The hydraulic cylinders are protected from damage and the cable chain swing drive, which gives an uninterrupted 188° arc of swing, is protected and regulated by a combination flow control and cushioning valve.

T.E.C. 142 for further details

N. P. Nelson Iron Works

The Nelson tractor shovel, model 200D, made its first appearance outside the U.S.A. when it was displayed at this Exhibition by Merton Engineering Co. Ltd., who are distributing the machines in the United Kingdom as an addition to their existing range. A product of N. P. Nelson Iron Works of New Jersey, the model 200D and the slightly smaller 150D, which have been operating in the U.S.A. for the past three to four years, are part of a range of loading and construction equipment manufactured by this company.

The Nelson 200D is powered by a 105 h.p. diesel engine and has, as standard equipment, a 2¼ cu. yd. rated capacity bucket capable of lifting a 13,000 lb. load. The bucket has 40° crowd at ground level and a discharge angle, at maximum height, of 50°. Maximum clear discharge height is 9 ft. 6 in. ('load-over' 12 ft. 3 in.) with a forward reach, at this height, of 2 ft. 2 in.; the manufacturers claim that these figures are unequalled in any other loader of comparable size. Power is transmitted to the driving axles by an Allison Torqmatic transmission consisting of a torque converter, planetary transmission and transfer gears; all clutches are hydraulically operated and run in oil and the torque converter has a stall ratio of 3.5 to 1. The transmission gives three forward and three reverse speeds (from 3.5 to 27 m.p.h.) and quick shifts under full load at maximum throttle without interrupting the power flow from the engine to the load. It also permits the rear axle to be disconnected for road travel. Timken-Detroit driving axles incorporate heavy duty, hypoid, torque proportioning differential gearing and planetary final drives in the wheel hubs. Standard tyres are 14.00 x 24 (12 ply) with 16.00 x 24 (12 ply) as optional extra equipment where high flotation is needed. Steering is power assisted to the rear wheels. Working brakes on all four wheels are hydraulically operated and vacuum boosted; in addition, a mechanical parking brake operates on the transmission output shaft. Hydraulic power is provided by a gear type pump driven from the transmission, with an output of 48 g.p.m. (181 litres p.m.). The control valve is of the two spool type with built-in adjustable relief valve. All rams are double acting with chrome plated piston rods and diameters of 6 in. (main lift rams) and 4½ in. (bucket rams). In the design of the Nelson tractor shovels, particular attention has been given to accessibility and operator comfort. The clean, spacious lay-out of engine, transmission and ancillary components gives ample room for easy and efficient performance of all maintenance and service operations. The driver's cab is comfortable and roomy, with excellent all-round visibility and the controls are conveniently placed for minimum fatigue.

T.E.C. 143 for further details

The Merton Sherman 'Universal'.

Public Works Productions Ltd.

On the Dunlop stand, this firm showed several forms of road-marking equipment made from Fortiflex rubber, and the display included three different bollards. One of these is an inverted rubber cone 21 in. high with a base diameter of 16 in. This type of indicator is proving very popular on the Continent, where it is being used in ever-increasing numbers. The hollow design enables these markers to be stacked, one on top of another, in a very small space. They are light in weight and the colouring of black and white bands is clearly visible. Another version of similar design is called the Truncator—a conical rubber marker with the apex cut away to give an 18 in. height. These bollards both have openings at the top suitable for carrying a short stick or metal rings for carrying flags or ropes.

A police warning sign was also shown, made in the form of a triangular rubber pyramid, again with an open top. Any wording can be supplied and the main advantage, apart from lightness and simplicity of storage, is that the message is shown on three sides as opposed to merely two.

T.E.C. 144 for further details

Five of the markers made by Public Works Productions Ltd.

The 'catseye' pounder foot.

Reflecting Roadstuds, Ltd.
A special pounder foot has recently been designed by this company to make the installation of their 'catseye' studs even simpler. A short detailed instruction manual is available from this firm and in this it gives a full account of the best method of laying 'catseyes'.

T.E.C. 145 for further details

Road Machines (Drayton) Ltd.
Among the exhibits which Road Machines (Drayton) Ltd. showed at the Exhibition was their new range of dumpers, the mono-rail transporter and a special display unit, featuring a model of one of the RoadMac batching plants. The new range of dumpers—RoadMac's 'Young Lions'—was on display for the first time. This range of three, consisting of the 15 cwt. capacity 'Whelp', the 22½ cwt. capacity 'Cub' and the 30 cwt. capacity 'Lioness', was launched early in September of this year and special attention has been paid to manoeuvrability. The steering axles are centrally pivoted, to give maximum articulation and this, together with correct weight distribution, ensures maximum traction under all site conditions, whether laden or unladen.

In the mono-rail transporter display, apart from gear driven and hydraulically driven power wagons already widely known throughout the world, Road Machines Ltd. showed a power wagon with hydraulically controlled tipping skip. While this has already been seen at overseas exhibitions during the past summer, it was exhibited for the first time in the United Kingdom at Olympia.

A scale model of one of the RoadMac range of batching plants was the main feature of a special display. This model was a replica of that supplied to the consortium of Cubitts, Fitzpatrick and Shand, which is at present in use on their Park Lane improvement project. This plant is a low level type, comprising a 90 cu. yd. four-compartment aggregate storage hopper, an 80 ton, four-compartment cement silo and incorporating a turbo mixer, to supply wet batches to truck mixers when used as agitators. A separate discharge can provide dry batches for normal charging of truck mixers.

T.E.C. 146 for further details

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Ruddock & Meighan Ltd.
This company are the manufacturers of additives to paint and road binders.

Stearine amine M.L. is an organic, solid, crystalline material, which, when mixed with binders such as tar or bitumen, imparts qualities of stronger adhesion. It is packed in paper-lined jute sacks containing 75 lb. and should be introduced into the spraying tanks on site. This additive, which is simple to use and quite harmless when mixed, is claimed to enable spraying to be carried out on wet surfaces and with wet aggregates.

T.E.C. 147 for further details

Safeticurb Ltd.
This company has marketed concrete reflecting kerbs for many years and a new type of Safeticurb has recently been introduced which combines a reflective haunch and surface water drainage system. This presents a 10 in. wide white marginal strip at the edge of the carriageway, the visibility of which is enhanced by a series of raised portions or 'pads', which reflect the light from vehicle headlamps as well as giving an audible warning to road users when they drive over them. The warning sound is particularly important in fog. Along the centre line of the top face is a narrow slot into which the surface water runs off the carriageway and the hardshoulder or verge. A concealed water channel discharges it into drains.

These kerbs are now being manufactured in four factories so located as to supply Scotland and Northern England without incurring excessive haulage charges. In spite of the limited distance over which the kerbs have been tried, reports of their practical value have been very favourable.

T.E.C. 148 for further details

T.P.T. Construction Products
Two products were displayed, Sonotube and Sonovoid, which are for use in the casting of concrete.

Sonotube is an expendable fibre form to provide a fast and economical method of forming round, clean columns of concrete. It can also be used to form an integral part of steel, pre-cast, pre-cast reinforced or in situ cast beams. It can be stored in the open with the minimum of protection from the elements. It is supplied in two types—'P' coated or 'W' coated: the 'P' coated type is for use where a clean finish is required and the 'W' coated type for use where the form can be left on the column as a protective skin.

Sonovoid is also a fibre tube, but designed for use in concrete roof, wall and deck slabs. It creates a space by displacing the concrete which does little work below the neutral axis, at the same time lightening the structure. It can be used in pre-cast or in situ work for unstressed, pre-stressed or post-stressed concrete.

T.E.C. 149 for further details

Winget Ltd.
Amongst the equipment shown on this stand, was the new 'Challenge' concrete truck mixer, which is mounted on an A.E.C. chassis. The main features of this machine are single lever control for all functions of charging, mixing, agitating and discharging. These functions are controlled without rods, cables or springs. A hydraulic transmission developed by Lucas is used to maintain constant drum agitating speeds irrespective of engine or vehicle speeds, and allows the full engine power to be used for vehicle operation over difficult terrain and on steep gradients.

T.E.C. 150 for further details

The Winget 'Challenge' truck mixer.

INDUSTRIAL NEWS AND INFORMATION . . .

THE recent success of experiments on the value of 'tidal flow' on main roads, during the morning and evening peak periods, has made necessary the development of a different method of marking traffic lanes. It has become imperative that the motorist be warned of the reversal of direction of carriageways and prevented from entering the wrong lane or crossing the markings. A method of channelling traffic moving against the heavy, peak-hour flow should be used in all places where 'tidal flow' is in operation, but at the same time it must be possible to reinstate the normal off-peak lanes as quickly as possible, after the majority of rush hour traffic has passed.

To gain these ends, the Westinghouse Brake and Signal Co. Ltd. have devised a method of raising a solid, 12 in. wall between traffic going in each direction, returning it to normal during off-peak hours and raising it again, in the position required to allow the 'tide' to flow the opposite way. The method this company proposes is a divider, consisting of a concrete 'kerb' wall, which can be raised 12 in. above the level of the carriageway or lowered so that the top is flush with the road surface. The divider runs the full length of that section of main road where reversal of the central lanes is required, but for ease of construction and operation it is made up of 14 ft. lengths. Normal road stud marking can be installed along the top of the divider. Raising and lowering the wall is carried out hydraulically using compressed air at 100 p.s.i. as the medium. Cast-iron cylinders, positioned at the junction of each 14 ft. section with the next and connected in series to the air supply are designed to control the speed of raising or lowering, using one pipe only for both venting and supply.

The installation of these traffic dividers consists of cutting and lining a 9 in. wide trench to replace the white painted lane markings. Into this trench hydraulic cylinders are placed at 15 ft. centres and connected with the air pipe. Accurate positioning is not essential—measurements to the nearest $\frac{1}{2}$ in. being sufficient—and no fixings are required for these cylinders, which merely rest on their own bases. The concrete lengths are then lowered to rest with their ends on each pair of cylinders. Again, positioning to close tolerances is not necessary and the blocks do not have to be fastened to the cylinders. The design provides self-clearing arrangements for any grit that may become worked into the trenches and thermal expansion and contraction is taken care of. During operation of the system, compensation is made for any tilting of the blocks and drainage throughout the entire length of the trench covers road flood conditions. Very little maintenance is expected as the whole system is designed to be robust enough to withstand the severest abuse by heavy vehicles, but it is possible that the cylinder seals may require replacement at five year intervals. However, should it be necessary to repair or replace anything, the system provides for isolated sections of the wall to be raised at will. The removal of any pair of blocks allows the replacements of a cylinder to be made in a very short space of time and the operation of the system to be resumed with great speed.

Compressed air has been chosen for the hydraulic operation of the cylinders as it has the advantage of being readily available, free, easy to store under pressure and expendable in exhaust. It does not cause costly losses or fouling in the event of leakage and it can be fed with additives to prevent freezing of any trapped or condensed water content. In this particular application it also has the distinct advantage over other hydraulic fluids of being virtually weightless, and enabling the system to be fitted over undulating sections of highway. The use of other pressure media would make it very difficult to maintain uniform pressures at low points and on hill crests, since the static head of the pressure medium would tend to raise sections of wall at low points, keeping them raised when the higher sections were flush with the road surface.

Safety precautions have been taken to ensure that motorists who do not look carefully where they are going are not taken by surprise or penalized too heavily for their errors. The top and sides of each section are to be fitted with 'cats eyes' to give visual warning when the divider blocks are raised and to mark the normal lanes when the wall is lowered. To overcome the inevitable case of the motorist who drives his vehicle astride the line while the wall is being raised—and who eventually finds his car 'jacked-up' underneath him and his wheels spinning in free air—it is possible to lower a short length and release him from his predicament with only localized interference with the system. Alternatively the whole length can be raised in stages, to allow the road misusers to mend their ways and return to the correct lane before it is too late. This however would complicate the design and increase the costs. The terminating blocks can be raised at one end only—forming a short ramp at each end of the wall. It is most important, and this cannot be too highly stressed, that warning signs be provided at the approaches and that they be unmistakable, unambiguous and such that no motorist, however careless, can avoid seeing them.

T.E.C. 151 for further details

Standard Bridge Railing

The Department of Highways, Ontario, has recently standardized on a form of steel bridge railing for use on road bridges in its area. The main reasons for standardization are good looks, certain strength, ease of maintenance and ease of erection. The photograph here shows a section of the design chosen, showing the upright posts and two sections of the connection rails and grid. The same and similar designs are now available in this country.

T.E.C. 152 for further details

On the left is a section of the bridge railing which is now becoming standard for all road bridges in Ontario, Canada.

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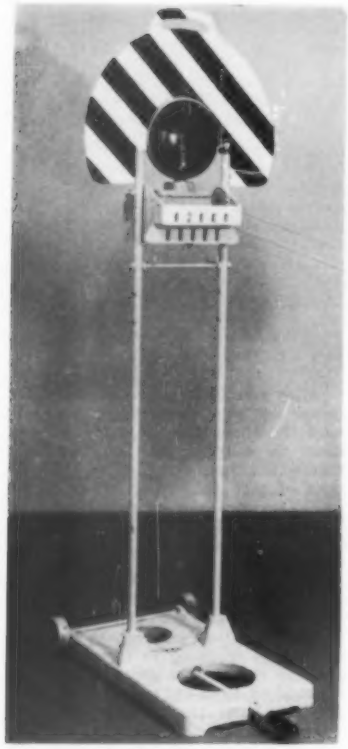


The Simplite beacon

William R. Sellwood Ltd.
At the request of the Hampshire County Council Surveyor, William R. Sellwood Ltd., have developed the Simplite beacon for the better protection of road workers and road works or obstructions. Basically it is a collapsible portable stand for approved road signs, surmounted by a lamp box and a halo of black and white stripes of striking appearance. The lamp box is adjustable for beam angle, taking either a standard square road danger lamp or a new transistorized flashing lamp, with a working life of 1,500 hours on two small dry batteries. The prototype sign has been thoroughly tested and it has been proved that it definitely causes the drivers of vehicles to reduce their speeds when passing the workmen.

T.E.C. 153 for further details

Parking Control System
The Parcoa system of parking control, described briefly in the November issue of *Traffic Engineering & Control*, has four main applications; for private car parks, such as those attached to factories, hospitals, universities, office blocks and government service parks, where only authorized persons are allowed to park; public car parks where a flat rate is charged for a day's parking, either with or without a contract arrangement; public car parks where a variable rate is charged; and in such parking places as members' enclosures at race-courses, sports arenas, stadiums and exhibition grounds. These four applications can be controlled by three quite separate developments of the same system.

A driver wishing to enter the parking area brings his car up to the drop arm barrier guarding the entrance, crossing a jump-proof treadle which switches on the mechanism. A card, procurable at a predetermined price from the management of the car park, is pushed into a slot in the face of an electronic locking device, mounted on a pedestal, within easy reach of the driver. Through the window of his car the driver can reach to insert his card without getting out of his seat or even opening the door. This device reads a magnetic code, which is invisible to normal vision, set into the plastic coating of the card. Unless this code is correct, and it can be changed for different parks and dates, the barrier will not rise. If, however, the card is valid for the park concerned, the servo-motor is actuated and the barrier raised to allow free entry to the park. As the car crosses a treadle set into the entrance roadway the motor is reversed and the barrier lowered into the closed position. The system is then de-energized until another vehicle crosses the first treadle and stimulates the mechanism afresh.

Two alternative methods, which are more suitable for certain categories of parking areas, can be used to unlock the barrier. The first of these, perhaps best applied to public parking places, is the use of a coin, or combination of coins, instead of the magnetized card. The second alternative uses a ticket. The crossing of the first treadle causes a ticket, stamped with date and time, to be partly extruded from the face of the machine. When the motorist pulls at the ticket to remove it, the motor operating the barrier is set in motion. Payment in accordance with how long a time is required can then be made to a cashier in the centre of the garage or park.

To open the exit routes, which are of course closed to prevent them being used as free entries, the same procedure is used with the card system as for entry. When coins or tickets are in use a token which is given as a form of receipt of payment is used instead. In both coin and ticket operated systems, entry can be permitted free of charge and payment made to operate the exit, and in all three systems provision has been made for the barrier to rise automatically on an impulse from a floor treadle.

As additional equipment, Parking Developments Ltd., offer interchangeable, locked cash boxes, automatic vehicle counters and signs which light up automatically when the car park is full. A capacity counter is also available, for use in conjunction with the 'Park Full' signs, and this will subtract cars leaving the park and switch out the sign until the same number of cars has entered and filled up the area.

The cost of the equipment for this system varies from £600 upwards, according to the size, layout and extra items required. Its advantages are claimed to be low operating costs, elimination of attendants, simplicity, high operating speeds and an accurate control of capacity. The only disadvantage of this system, compared with attendant controlled parking, is the lack of influence on driver behaviour inside the parking area. However, intelligent laying out of the bays can overcome much of this slight disadvantage and the advantages already outweigh it.

T.E.C. 154 for further details

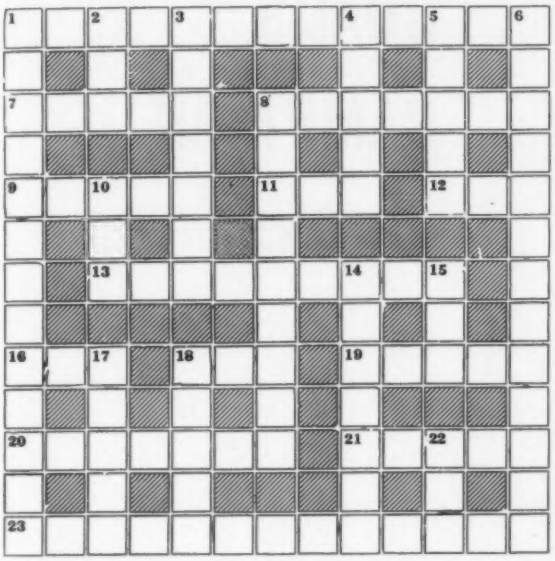
Tyre Armour
For most shovel operators a significant reduction in tyre replacement and repair will prove the principle advantage of the 'Granite' chain-mail tyre armour now available from Bray Construction Equipment Ltd. Early trials have demonstrated this on a local authority's refuse tip, where down-time resulting from punctures has been practically eliminated. Similar results have been obtained in quarries and on demolition sites. The 'Granite' chain is made from high-tensile manganese steel, for lightness and a long working life. Its formation gives a strong tractive grip and a highly efficient self cleaning action. Simple to fit, it is built to ensure the right degree of flexibility round a tyre. In fact a unique factor of its operation is the laying down of a protective track in advance of tyre contact with the ground. This chain-mail tyre guard has shown the added advantage of countering any tendency there may be for wheel spin. It also enables operators to use tyres which would have been discarded by reason of their excessive wear. 'Granite' tyre armour is available in a complete range of sizes to suit any requirements.

T.E.C. 155 for further details

The Parcoa control barrier

TRAFFIC ENGINEERING CROSSWORD NO. 7 by YEO

AMONG the clues and solutions will be found traffic engineering terms defined in the VOCABULARY OF TRAFFIC ENGINEERING TERMS published for *Traffic Engineering & Control* by Printerhall Ltd., and a copy of which is sent free to all subscribers to this journal. Copies are also available at 2s. 6d., post free, from the Circulation Manager, Traffic Engineering & Control, 34/40 Ludgate Hill, London, E.C.4.



SOLUTION TO CROSSWORD NO. 6

F	I	S	H	E	R	■	■	C	A	S	S	I	E
I	■	P	■	N	■	S	■	A	■	R	■	E	R
B	I	O	S	C	O	P	E	S	■	A	B	N	E	R
U	■	O	■	H	■	A	■	P	■	B	■	E	■	O
L	I	F	E	A	L	L	■	S	C	I	S	S	O	R
A	■	■	■	I	■	P	■	■	■	A	■	C	■	S
■	C	H	A	N	N	E	L	T	U	N	N	E	L	■
■	■	A	■	■	■	E	■	E	■	■	■	N	■	■
■	W	E	A	V	I	N	G	L	E	N	G	T	H	■
F	■	M	■	I	■	■	■	E	■	O	■	■	■	V
O	P	O	S	S	U	M	■	P	R	O	F	I	L	E
R	■	S	■	I	■	I	■	A	■	D	■	D	■	N
M	O	T	E	T	■	M	E	T	A	L	L	O	I	D
E	■	A	■	O	■	I	■	H	■	E	■	L	■	E
R	O	T	A	R	Y	■	■	I	S	L	A	N	D	■

Across

1. It has two or more arcs and a common tangent. (8, 5).
7. Can be external or internal. (5)
8. A learner in temperas has grievances. (7)
9. 11 and 13. Times between contact and drum. (5, 3, 9)
12. The Cockney's rudder is wooden. (3)
16. Dropped his firearm. (3)
18. Helps to detect the car. (3)
19. Cabs I find in disorder. (5)
20. Couldn't care less? (7)
21. Tarka was one. (5)
23. . . . More than coronets. (4, 6, 3)

Down

1. The eiderduck. (9, 4)
2. Myself, I lead up to an honour in France. (3)
3. Dispossessions in law. (7)
4. Noise in the Clan Gordon. (5)
5. Frantic fury in the mountains. (5)
6. Could be a transition bend. (8, 5)
8. Practice of a busy housewife? (9)
10. 15 is a signal for this. (3)
14. He'd always get you a taxi. (3-4)
15. See 10. (3)
17. Mother studies the wine. (5)
18. 'The nectarine and curious . . .' (Marvell). (5)
22. In tears of shame. (3)

New Publication

The Landscape of Roads by Sylvia Crowe, Architectural Press, 18s. 6d.

The author makes a plea for greater consideration being given to the landscaping of roads, so that they fit the better into their surroundings. The ideal after which Miss Crowe seeks is for roads to merge imperceptibly into the landscape, but she accepts that with the construction of roads on modern lines and scale this is unhappily rarely possible. As an alternative, she gropes after ways and means of mitigating the evil of scarring the countryside so that the least offence is given, and the modern highway becomes as unobtrusive as possible. Miss Crowe cites a number of examples illustrating the aesthetic good and the unaesthetic bad, with numerous photographs from many countries. Hers is a good case, and all who resent unnecessary defacing of town and country, and reject the argument that it is inevitable, will be grateful to her for making it so convincingly.

Industrial News—*concluded from page 562.*

Armour Hess Chemicals, Ltd.

This company are, amongst other things, manufacturers of Duomeen T, an additive for improving the qualities of adhesion in tar and bitumen binders. Duomeen T is a 99 per cent active chemical containing 85 per cent pure diamine with the general formula $R.NH.C_3H_6NH_2$, and surface active ingredients. It is a pale paste which softens at 110°F. and liquifies at 120°F. With its paste consistency this additive dissolves rapidly in the hot binder and, while it is classified as a non-hazardous chemical, it is a mild alkali and suitable clothing and goggles should be worn by the handlers. In the quantities used in solution, it is quite harmless to plant and animal life.

T.E.C. 156 for further details

A.R.P.S. Trenching Machine

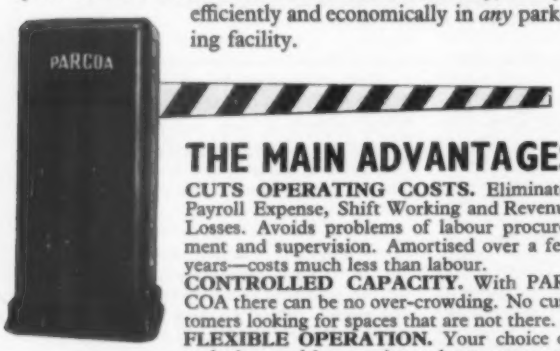
Hand-propelled and self-propelled trenching machines are available from the A.R.P.S. Corporation of America. One of their new models, the MA, named the Trench Devil, can dig at rates from 1 to 1,200 ft. per hour. It is a self-propelled machine designed for narrow trenches such as those required for the laying of small diameter pipes and electric cables. Digging capacity is up to 8 in. wide by 4 ft. deep, through chain cutters and a hydraulic drive. Controls for all movements of machine and boom are grouped to the left of the engine. Operation is simple, and a reversible conveyor can be fitted to either side of the digger to give accurate placing of dirt and enabling digging to be carried out from either direction close to obstructions such as walls or fences.

T.E.C. 157 for further details

STOP parking control problems with

PARCOA
AUTOMATIC PARKING SYSTEMS

PARCOA automatic parking systems provide the complete mechanical answer to trouble-free control. This well-proven system can be relied on to handle traffic smoothly, safely, efficiently and economically in *any* parking facility.



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